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The American Institute. OUR Western readers will be pleased to learn that the general meeting of the American Institute of Electrical Engineers will be held in Chicago this year, the date fixed upon by the managers being June 6 and 7. This move is not now an experiment on the part of the Institute, as general meetings have already been held in former years in Philadelphia and Boston. The Boston meeting of two years ago is well remembered as an especially pleasant and successful one, the hospitality of the Boston Electric Club, and of the Thomson-Houston and the West End Street Railway companies on that occasion making the trip much more agreeable, not to say profitable, than it would otherwise have been. The Western meeting will, we have no doubt, result in the acquisition of many new members, as the present membership of the Institute does not include as many representatives from that section of the country as it deserves to have. The Chicago meeting should, and doubtless will be attended by all who can possibly make arrangements to be present and assist in the discussion of the papers to be presented, since this feature is one of the distinguishing characteristics of the Institute, and the one that has made its former meetings of such great interest and profit.

Weston Measuring Instruments. WE publish in this issue the last of a series of articles on the varied uses of the Weston electrical measuring instruments. After a perusal of these articles the reader will doubtless be ready to admit that the Weston instruments form a complete laboratory outfit in themselves. Very few even of those who consider themselves fairly well acquainted with these instruments have understood the remarkable range of applications to which they are adapted. Many of those who have used the Weston voltmeters and ammeters in central station work will be surprised to learn of their varied use in the measurement of large and small currents, the resistance of batteries, the voltage of primary and secondary cells, and the constants of incandescent lamps, to say nothing of their applications to the testing of lines and machines, the testing of accumulators and similar uses. The remarkable flexibility of these instruments as station and laboratory accessories and their adaptability at the same time to very rough work where accuracy is not essential, and to the minute measurements of the laboratory, where the most extreme delicacy is requisite, make Dr. Maschke's articles of the greatest interest to central station men as well as to electrical engineers who have testing of any kind to do under conditions that render it impossible to use other than portable instruments.

Electrical Literature. THE growing importance of electrical literature from the standpoint of the public is well shown by the recent publication by the Boston Public Library of a 24-page list of all the works on electricity, not including the telegraph and the telephone, to be found in that library. It contains not far from 1,000 titles, and is on the whole an admirable piece of work. Coming from a library of such importance and high standing, this publication has considerable significance, as it indicates that the demand of the general reader for this class of literature is of such a nature that it is necessary to place at his disposal the very best means for ascertaining what the library possesses in this special field. With the single exception of the St. Louis Public Library this is, so far as we are aware, the first attempt to afford material assistance to the general reader of this important field of literature, to which accessions are now of almost daily occurrence. The periodical literature of electricity has already grown to be so voluminous that there is need of a special index to cover publications of this class in the English, German and French languages. As might be expected the list of the Boston Public Library scarcely attempts to enter this field, the articles of the Philosophical Transactions of the Royal Society of London being almost the only ones which have been entered in the list. It often happens, however, that the greater part, and sometimes all of the information to be secured upon certain subjects, is contained in the periodical literature of the day, and the reader who seeks the fullest and best information should be able to consult the original memoirs on the various subjects. Just here we would like to point out that in one important particular English electrical books of the present day are much more satisfactory than those of American writers; we refer to the admirable practice which English authors have of referring the reader to original memoirs and various other sources of information, to which reference may be made by the student who desires to pursue the subject farther than the necessarily limited space of a text-book permits the author to go in his treatment of it.

New York Subways. MUCH has been said and written against running wires underground. Most of it, however, appears to have emanated from the companies who did not wish to be put to the trouble and expense of making such a change, and it was, therefore, not of an impartial nature. That telegraph, telephone and electric light wires may be run successfully underground no person whose knowledge is up to date can deny. It has been done abroad for many years past, and is now being done in this country. It is only a question of cost and intelligence, but not one of possibility. It may be too expensive in some cases to be practicable; a conduit with good insulated wire costs more than poles with cheap insulation, and requires a greater amount of intelligence on the part of constructors and operators in selecting materials, laying, making joints, testing, etc. The New York subways are certainly a very good illustration of the fact that a perfectly satisfactory and permanent underground conduit can be built, even in a city in which there already exists a dense network of underground pipes of all sizes and descriptions. With good engineering skill and plenty of money, the work has been very creditably done. It appears, however, from rumors, that the management of the whole concern has been anything but creditable, that it was used to swell the pockets of Tammany politicians, and was run in the interest of several powerful electric companies, who have arranged matters so that any competing company would be hampered to such an extent that it could not compete successfully. The correctness of these rumors we neither deny nor confirm, but merely give them as they reached us. If they are true it would readily explain why it was that such high rentals are charged. It is stated by a presumably good authority that such conduits ought not to cost more than about $3,000 per mile per duct. An annual rental of $800 to $1,000, therefore, seems to be entirely too high when it is considered that the amortization, repairs and maintenance in a permanent structure of that kind is, or ought to be, very small. On account of this exorbitant rental some parties claim that the electric companies should be allowed to build their own ducts. It will readily be seen, however, that in a city like this, with so many different companies, such a complicated system would be entirely out of the question. A more satisfactory way would be to have the city lay a uniform system at its own expense and then to charge a fair price as rental, which would encourage rather than discourage the electric lighting in the city. This, however, assumes a clean and intelligent government, which New York unfortunately cannot claim to have. With such a system of air tight iron ducts it is strange that the Brooks system of oil insulation has not yet been applied. As this would enable the number of wires in the electric lighting ducts to be made probably four or five times as great, it would decrease the rental per wire in proportion, while at the same time the insulation would be far cheaper than the present expensive cables.

Electricity in Mining Operations. IN THE ELECTRICAL WORLD of March 5 the subject of power transmission was treated by Mr. Schlesinger from the standpoint of the man who owns the plant and rents his power to the consumer. This method of treatment gave a set of very interesting curves showing the cost of power transmitted at various voltages and for different distances at a constant voltage. Looking at the problem from this standpoint it was pointed out that the question to be considered is not so much that of making the cost per horse power delivered by the motor a minimum, as it is one of making the net profits derived from each horse power available at the generating plant a maximum. In this consideration the fact that the conditions of minimum cost of operation do not necessarily give the most efficient plant plays an important part. In a recent paper by Mr. Irving Hale, the second part of which is given in our columns this week, this subject is discussed in the most comprehensive way with the view of pointing out the present limitations of electric power in its application to mining operations. Mr. Hale has taken a very conservative view of the situation. His aim has been to point out the fact that there are at present certain well defined and easily ascertained limitations beyond which the use of electric power in mining operations would prove uneconomical and therefore undesirable, and he has in his very exhaustive study shown what these limitations are under the specified conditions. This does not mean, however, that he takes a pessimistic view of the applications of electricity to mining operations, as he points out that there is at the present time a wide and profitable field in this direction, and that the next few years will see numerous developments in this branch of electrical engineering. It is expected that certain improvements in present methods of transmission will gradually extend the limits which now define the economical use of electricity for this class of work. But Mr. Hale indicates that there are certain well defined secondary limits, to pass which some very radical changes in the whole method and apparatus employed will be necessary. He is an ardent advocate of the direct method of transmission of power as distinguished from the method of double conversion. He does not deny, however, that the three-phase system may render practicable transmission to distances far beyond what may be obtained by continuous currents, provided the price of coal is high enough to give sufficient margin to pay interest on the cost. A single instance which he cites is that a double conversion plant using 6,000 volts in the primary costs less than a direct transmission plant using 220 volts when the distance is greater than 8,700 feet, and less than a 440-volt direct plant when the distance is greater than 17,600 feet. In this, as in other cases, however, the comparative efficiencies of the two systems must be taken into consideration when determining which plant should be used. Here the total efficiency of the double conversion plant at 17,600 feet is given as 44 per cent., and the efficiency of the direct plant 55.4 per cent. In considering such problems as this it is at once evident that the local conditions must be carefully taken into account, for in the case just cited the low efficiency of the double conversion system would have little weight provided there was an abundant supply of water power which would otherwise be unused. Up to the present time the use of electricity in mining operations has been far below that which it may be expected to reach in the near future, since many of the large electric companies have for the last two or three years been so completely occupied in developing the electric railway that they have had very little time or energy to give to the very important field of electric mining.

Full Text of the Recent Storage Battery Decision.

[United States District Court, Southern District of New York. The Accumulator Company vs. the New York and Harlem Railroad Company. Final hearing, in equity. Frederic H. Betts, for complainant; Thomas W. Osborn, for defendant. Justice Coxe.]

This is an action for infringement of reissued letters patent No. 11,047, granted to the Electrical Accumulator Company of New York, as assignee of Joseph Wilson Swan, on Dec. 17, 1839, for an improvement in secondary batteries.

The invention of the reissue is intended to facilitate the construction of secondary battery plates by preparing them with perforations, cells or holes extending through the plate, in which holes the active material is packed.

The original patent, No. 312,599, dated Feb. 18, 1885, was considered by this court in the case of the Accumulator Co. vs. Julien Co., 38 Fed. Rep., 117. The original was held invalid (page 140-142) for the reason that it described and claimed a plate, the outer surface of which might be covered by the active material. This construction, in view of the work done by Prof. Eaton, was held to be anticipated.

The theory of the reissue is that the valuable feature contributed by Swan consists in confining the active material to the holes, without permitting it to extend beyond them to the surface of the plate. That portion of the original which refers to the coating of the outer surface of the plate has been omitted in the reissue. In other respects the description is unchanged.

The claim is as follows:

A perforated or cellular plate for secondary batteries, having the perforations or cells extending through the plate, and the active material, or material to become active, packed in the said perforations or cells only, substantially as described.

This is the claim of the original, except that the word *only* has been added

The patent cannot be criticised as a reissue. The claim, instead of being broadened, is greatly restricted. The application was filed within a reasonable time after the inventor was informed of the facts which made a narrower claim necessary. The facts bring the case within the provisions of section 4,916 of the Revised Statutes.

The field of invention is, concededly, a narrow one.

The counsel for the defendant correctly states that Swan's improvement consists "wholly in the idea of putting on the surface of a perforated plate for secondary batteries no active material beyond the contents of the perforations; everything except this is conceded to be old."

The date, *de jure* of Swan's invention is Jan. 18, 1882 Prior to that time Prof. Eaton had filled the perforations, but he had covered both sides of his plate as well. Mr. Brush had rammed or pressed absorptive substances, in the form of dry powder, into grooves or receptacles without covering the surface of the plate. No one had packed active material into holes extending through the plate, confining it entirely to these holes. This combination was original with Swan. Did it involve invention? In approaching this subject it is well to remember, as the court has frequently had occasion to remark before, that we are dealing with a comparatively new and abstruse art, where the most important results are said to follow from changes, apparently, of the most unimportant character.

Complete success has not been attained, but, if we may credit the statements of those who are entitled to speak *ex cathedra* on the subject, the rapid strides in that direction during the last decade are due to changes of form and material which, in many other arts, would be insufficient to support invention.

The substitution of one material for another in a door knob is the work of the mechanic, the substitution of one material for another in secondary battery electrodes may solve a problem which will revolutionize the motive power of the world.

In holding that there is sufficient invention disclosed to support the reissue, the court is influenced by the following considerations:

The Swan electrode is to-day the electrode of commerce. It has largely taken the place of other structures, and is almost universally used. The advantage of having the active material composed of small disconnected masses, packed in holes extending through the plate, is unquestioned. The electrolyte is thus permitted to reach and operate upon both sides of these small masses, instead of on one side where the active material is packed in cells or pockets. The expansion and contraction of the electrode when the battery is in use causes the active material, if packed in cells or grooves or spread upon the surface of the plate, to crack, and portions of it to be pushed out of place and to fall away. These defects which produce "buckling," "short circuiting" and other disastrous results are entirely remedied by the Swan construction. If one of the small masses in his plate becomes injured or falls out it does not affect injuriously the other parts of the electrode.

As Sir William Thomson puts it: "The perforated plates have also the great advantage of extending the area of electric communication between the continuous metallic conductor and the porous or spongy material and so minimizing the electric resistance. The application of the oxide in the form of numerous mutually detached parts, separately held by the perforations, has also a great advantage in almost annulling the warping or fracturing effects of oxidation to which the active material is exposed in the charging and discharging of the battery."

It is true that the step from the structures of Eaton and Brush to the electrode of Swan seems to be very short when looking back upon the work of these men. But standing where Brush and Eaton did and looking forward to the ideal electrode which should avoid the then existing difficulties and possess the excellencies of the present Swan structure, the steps undoubtedly seemed many and long.

If it had occurred to Eaton to scrape off the active material from his plate, leaving the holes full, he would have hit upon the invention. But it never did. If Brush had thought of punching out the bottom of his receptacles and had then rammed them full of active material without covering the external plate he would be entitled to the credit of having made the successful structure. But he did not think of it. The experiments at that time seemed to be proceeding along different lines, the object being to keep as much material as possible upon the surface of the plate.

The conviction cannot be avoided that the idea which has made these plates a commercial success was first given to the world in a practical embodiment by Mr. Swan.

Confirmation of these views is found in two recent decisions of the Supreme Court. In *Washburn & Moen Company v. Barbed Wire Company* (decided Feb. 29, 1892) the court says:

The difference between the Kelly fence and the Glidden fence is not a radical one, but, slight as it may seem to be, it was apparently this which made the barbed wire fence a practical and commercial success. The inventions of Hunt and Smith appear to be scarcely more than tentative and never to have gone into general use.

The sales of the Kelly patent never seem to have exceeded 3,000 tons per annum, while plaintiff's manufacture and sales of the Glidden device (substituting a sharp barb for a blunt one) rose rapidly from 50 tons in 1874 to 44,000 tons in 1886, while those of its licensees in 1887 reached the enormous amount of 173,000 tons. . . . Under such circumstances courts have not been reluctant to sustain a patent to the man who has taken the final step which has turned a failure into a success. In the law of patents it is the last step that wins. It may be strange that, considering the important results obtained by Kelly in his patent, it did not occur to him to substitute a coiled wire in place of the diamond-shape prong, but evidently it did not, and to the man who did ought not to be denied the quality of an inventor.

In *Magowan v. New York Belting Company*, 141 U. S., 332, it was held that the fact that the patented improvement "went at once into such an extensive public use as almost to supersede all packings made under other methods . . . was pregnant evidence of its novelty, value and usefulness."

These quotations seem peculiarly applicable to the present controversy. The principles which are there so clearly and pointedly reaffirmed require a decision sustaining the validity of the complainant's patent.

As to defendant's infringement there can be no doubt.

The question arising upon the expiration of the Danish patent has not been argued. The casual examination which the court, in the absence of explanation, has been able to give to this patent leads to the conclusion that it is not for the same invention as the Swan reissue.

There should be a decree for the complainant.

Mr. William Bracken, president of the Consolidated Electric Storage Company, exclusive licensee of the Brush patents, has sent us the following comments on some of the published statements regarding the scope of this decision:

"The newspapers in the last few days have been made the vehicle for conveying to the public the idea that Judge Coxe, of the United States Circuit Court for the Southern District of New York, had, in the case of the Accumulator Company against the New York and Harlem Railroad Company, awarded to one J. W. Swan, and his assignees, the sole and exclusive right to a perforated support plate for storage batteries; that without such a plate as Swan claims no practical storage battery had ever been made, and that this decision postpones indefinitely the use of storage battery cars and the like. An examination of the decision itself will show how misleading are these statements.

"Swan was not the inventor of the perforated plate. On the contrary, Judge Coxe took that claim away from him in the case of the Electrical Accumulator Company vs. Julien, and gave the broad claim to Brush in the case of the Brush Electric Company against the Electric Accumulator Company. Neither has Swan the right to put active material in the perforations or apply it in any way to a perforated plate, for that has been awarded to Brush.

"His claim is the narrow one of putting the active material in the perforations *only*. His claim does not cover the method of putting the active material in the perforations and at the same time spreading it over the surface of the plate. Neither does it cover the putting the active material in any manner in grooves, receptacles or perforations that do not extend wholly through the plate. In fact, the claim is as narrow as it is of doubtful utility. The progress of the storage battery industry will not be retarded one hour by the decision."

An Hydraulic Gear for Street Cars.

A patent is about to be issued for an interesting hydraulic gear or clutching mechanism, the invention of Mr. Finis M. Barney, of Kearney, Neb. It is an application of the differential or epicyclic principle with an hydraulic instead of a fixed connection. The mechanism consists essentially of two rotary pumps placed side by side, having elliptical chambers placed eccentric to their axis of rotation. To a shaft, which enters the chamber of each pump, is keyed a collar slotted to receive a solid partition. This collar fits nicely against one side of the chamber but leaves a crescent shaped opening on the other, which opening is filled with some fluid, preferably oil. The collar revolving carries with it the partition, which forces the fluid through outlets and a by-pass valve into the other side.

So long as the two shafts revolve at the same speed no motion is given to the cylinder which incloses the chamber; if, however, one of the shafts moves faster than the other, the cylinder, to relieve the strain between the partitions of the two pumps, will take a speed equal to half the difference of the speeds of the two shafts. The direction of revolution of the cylinder depends upon which shaft is increased in speed. The circumference of the cylinder may be a pulley, a sprocket, friction or cog wheel, and it is the movement of this that is utilized. This gear can be applied to any kind of work, but perhaps its special field was intended to be that of street car propulsion. In that case the armature of a motor is keyed to each of the pump shafts. As long as the speed of the two motors remains the same the car does not move; it is driven forward or backward according as the speed of either motor is increased. The inventor has made several modifications of this principle, especially one for motors, where the field and armature both revolve. The efficiency of the gear is claimed to be very high.

The Influence of Polyphase Currents on Telegraphic and Telephonic Circuits.

During the working of the Lauffen-Frankfort transmission plant, says *The Electrician*, of London, the German postal telegraph authorities carried out a series of experiments with a view of testing the effect upon their lines of circuits carrying polyphase currents. On the first four single wire telephone circuits selected, which varied in length from 1 mile to 3½ miles, and which were at an average distance of 10 metres from the disturbing circuit, a constant humming was heard, which in wet weather rendered all conversation impossible. Tests were next carried out on two private telephone lines. One of these started at a great distance from the polyphase current wires, and crossed them at a given spot. The other line ran alongside the Lauffen-Frankfort circuit at a distance of from 5 to 15 metres for a little over half a mile. Both lines were rendered useless.

On the Heilbronn-Mosbach circuit, 18 miles long, telegraphic communication was exceedingly difficult. On several other telegraph circuits whenever 25,000 volts were applied to the Lauffen-Frankfort line the armatures of the electromagnets kept up a continual vibration. Experiments were also carried out on the Stuttgart-Heilbronn double-wire telephone circuits (7½ miles). With 10,000 to 15,000 volts on the Lauffen line a noise was heard which increased with the voltage applied until with 25,000 volts on all conversation was rendered inaudible. The general conclusions to be drawn from these experiments are as follows: (1) The influence of polyphase currents (increasing with the voltage) was felt on lines traversed by telegraphic and telephonic currents, and placed at an average distance of 10 metres from the disturbing circuit, for stretches ranging from ½ to 18 miles. (2) Lines merely crossing the Lauffen-Frankfort wires were disturbed, as well as complete metallic circuits.

Moonlight Tables for May, 1892.

Herewith we give Mr. H. W. Frund's table of lighting hours for the month of May, under his modified form of moon schedule:

TABLE NO. 1. Standard Moonlight, Philadelphia System.

Date.	Light.	Date.	Exting.
1	11:40 P. M.	2	4:00 A. M.
2			
3	12:25 A. M.	3	3:55
4	1:00	4	3:55
5	1:25	5	3:55
6	1:45	6	3:55
7	2:10	7	3:50
8	2:30	8	3:50
9	2:50	9	3:50
10	No light.	10	No light.
11	No light.	11	No light.
12	No light.	12	No light.
13	7:35 P. M.	13	10:10 P. M.
14	7:35	14	11:10
15	7:40	16	12:05 A. M.
16	7:40	17	12:55
17	7:40	18	1:35
18	7:40	19	2:10
19	7:40	20	2:40
20	7:45	21	3:05
21	7:45	22	3:30
22	7:45	23	3:35
23	7:45	24	3:35
24	7:45	25	3:35
25	7:45	26	3:35
26	7:50	27	3:35
27	7:50	28	3:35
28	7:50	29	3:35
29	7:50	30	3:35
30	7:50	31	3:35
31	11:25	1	3:35

Total hours lighting, 144.00.

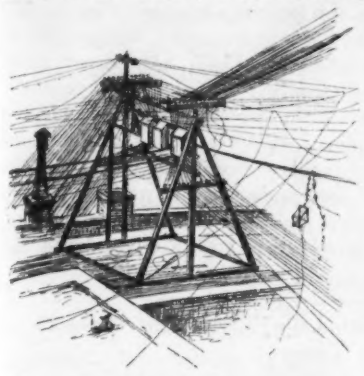
TABLE NO. 2. Frund's New Moonlight System.

Date.	Light.	Date.	Exting.
1	7:25 P. M.	2	4:00 A. M.
2	7:25	2	12:00 M.
3	12:25 A. M.	3	3:55 A. M.
3	7:25 P. M.	3	12:00 M.
4	1:00 A. M.	4	3:55 A. M.
4	7:25 P. M.	4	12:00 M.
5	1:25 A. M.	5	3:55 A. M.
5	7:25 P. M.	5	12:00 M.
6	1:45 A. M.	6	3:55 A. M.
6	7:30 P. M.	6	12:00 M.
7	2:10 A. M.	7	3:50 A. M.
7	7:30 P. M.	7	12:00 M.
8	7:30	8	12:00
9	7:30	9	12:00
10	7:30	10	12:00
11	7:35	11	12:00
12	7:35	12	12:00
13	7:35	13	12:00
14	7:35	14	12:00
15	7:40	15	12:00
16	7:40	17	12:55 A. M.
17	7:40	18	1:35
18	7:40	19	2:10
19	7 40	20	2:40
20	7:45	21	3:05
21	7:45	22	3:30
22	7:45	23	3:35
23	7:45	24	3:35
24	7:45	25	3:35
25	7:45	26	3:35
26	7:50	27	3:35
27	7:50	28	3:35
28	7:50	29	3:35
29	7:50	30	3:35
30	7:50	31	3:35
31	7:50	1	3:35

Total hours lighting, 201.40.

Underground Wire Ducts in New York City.

The system used in New York for running electric light, telegraph and telephone wires underground is now, and has been for some time, in successful operation, having passed beyond question what might be called the experimental stage. The following short description of the present system and methods, the progress made, and the experiences which the company has had, may therefore be of interest at the present time. The systems used by them were described in our columns some years ago, but the company has made sufficient improvements since then to warrant the publication of an additional article on the subject.



SOME OVERHEAD CONSTRUCTION.

Extent.—At the present time the company has completed from 1,500 to 1,600 miles of single duct, averaging 2½ and 3 inches in diameter, from which it will be seen that there are probably more undergrouud ducts in New York City than in any other city in the world. As the average trench contains about 10 ducts this corresponds to about 150 miles of trench. The number of ducts in a trench, however, varies very greatly, a large portion of their system consisting of a single duct only; a few in the neighborhood of the telephone exchange run up as high as 104 ducts in a trench. At present the ducts are about half filled, but this also is different in various localities, as in some places they are completely filled, while in others they are entirely empty.

Systems.—In laying these conduits a number of different systems were used, some of which were found to be entirely useless while others were more or less satisfactory according to circumstances. Among those used and tried may be mentioned the following: The Wychoff system consists of a creosoted wooden duct having a square cross section bored with a round hole about three inches in diameter; these wooden ducts are laid in a covered box. The pieces are in long lengths and fit into each other at their ends like pump logs. It is estimated that about one-sixteenth of the subways in New York are laid with this system. Its chief advantage is cheapness, and it is claimed by the consulting engineer, Mr. Davis, that such ducts will stand a very long while, probably 15 to 20 years if properly creosoted. Their specifications call for a certain definite amount of compound which must be absorbed per cubic foot of the duct. The objections to it are that it cannot be used in the neighborhood of the Steam Heating Company's pipes, and that as the logs cannot be bent the trench must have a clear way throughout its entire length. For the same reasons it necessitates having manholes wherever there is a change of direction, in the street or duct.

A system using earthenware pipes of a rectangular cross section having a horizontal shelf in the middle dividing them into two halves, each of which is equivalent to three of their ducts, is recommended by their engineer as a very satisfactory one under certain conditions. It is used largely in the Western cities. The objections to it are similar to those just mentioned, in so far that it requires a clear way and a straight path, both of which are difficult to obtain in streets like those of New York City, which are already filled with so many other pipes. The joints of these earthenware pipes are wrapped on the outside with a woven fabric impregnated with asphalt; the joints thus made possess a remarkable strength, being at the same time impervious to water. It is stated that quite a number of three-foot lengths can be joined together in this manner, and will then form practically a single piece, which can be handled as one. This system is not in use in New York.

The Dorset system is composed of blocks made of some compound resembling asphalt or pitch having numerous holes through them. These are joined end to end by having a paper sleeve inserted in the tubes, the joints being then filled with liquid asphalt. The trouble experienced with this has been that these paper sleeves become moist, and will then pack and clog when the cables are being drawn through; this has been found to be a very serious objection. Another is that like all such sectional blocks, if the conduit sags at any place the joints are bound to open.

Another system used was made with zinc pipes laid in concrete. The great objection to this was found to be that the thin zinc pipes were very apt to become bent or dented, therefore partially closing the duct. In many cases the men were compelled to fairly drill out a number of ducts laid in this manner, and they therefore condemn the system as impracticable.

In another system used by them the ducts are made of stovepipe iron lined with cement. The iron piping is placed on end and a core or plunger is inserted, while liquid cement is poured around it and allowed to harden. The ducts are then laid in cement, as in the other system. It is estimated that about one-eighth of their ducts are made of this pipe. Although these have proven more satisfactory than many of the other systems mentioned above, yet they have the disadvantage that a blow received from the outside, either in laying them or subsequently, will crack or break the cement and thus clog up the duct.

Still another system used for a short distance is that known as the Johnstone, made of cast iron sectional ducts. This has been described so frequently, and illustrated so fully, that it is unnecessary to repeat the description here.

By far the larger part of their ducts are made of wrought iron or steel pipes laid in cement. These they have found to be by far the most satisfactory under the circumstances. Besides being permanent and not subject to any deterioration, they have the very decided advantage over all the others in that these pipes may be sprung so as to pass around the numerous pipes and other obstructions found in the streets, and they may also be bent quite easily around curves if these curves are not too sharp. Among other advantages the tubes are perfectly tight and the joints smooth. They are not so easily injured by the laborer's pick, which has been found to be one of the greatest enemies of the Subway company. They will last practically forever and are not affected by the gases nor by the heat from the steam heating pipes. Another advantage which may be claimed for them is that the iron pipes probably insulate magnetically the wires in one duct from those in another, thereby diminishing the inductive effect between them; it may, however, increase the induction effect between wires in one duct. A disadvantage lies in the fact that the pipe itself is electrically grounded and in this respect it compares unfavorably with creosoted or earthenware ducts.

The pipes used in this system are 2½ to 3 inches in diameter inside, and are made of good quality of steel or wrought iron. The cost of the pipes alone is from 22 to 23 cents per foot. They are coated with a japanning compound, into which they are dipped while hot, and then allowed to drain, a process which costs about one cent per foot. They are joined at the ends by a regular pipe screw coupling, in which a vanishing thread is used, making a very perfect, tight and strong joint. These pipes, see Fig. 1, are laid beside or over each other, as the case may be, in a trench, the bottom of which is first covered with a layer of cement 3 inches thick, on which they are laid about 1½ inches apart; they are then covered with another layer of cement, after which another row of pipes is laid 1½ inches above the first, which is continued until all the ducts are laid. At the sides and top the cement has a thickness of 3 inches, the same as at the bottom. The sides are boarded both for the sake of protection and as a mold for the cement. Over the pipes are placed 2½-inch creosoted planks, the tops of which must be at least 16 inches below the top of the pavement. These blocks shield the ducts from the workman's pick, which experience in the past has shown to be a real source of danger. At first, 2½-inch pipes were used, but later on it was found necessary to use 3-inch pipes instead. At every street crossing there is a manhole, but if the square is a long one there are one or more between these. It is not thought well to have manholes more than 250 feet apart. They are built of brick, and made as nearly water tight and gas tight as possible, but it is found that even with the greatest care the gas from the earth will find its way into them. They are of all shapes and sizes, according to the condition of the location; it was in fact often found exceedingly difficult to locate them among the dense network of pipes already in the streets.

Some of the arrangements in these manholes will be seen in the accompanying figures. Fig. 2 shows one of the older ones in which the cables were run in a rather careless manner; it would be practically impossible to obtain access to those in the rear corner. Fig. 3 shows the arrangement at present adopted, in which the cables are readily accessible throughout their whole length. Fig. 4 shows the system adopted in making and placing the joints in the telegraph and telephone cables. In every manhole each cable is tagged systematically.

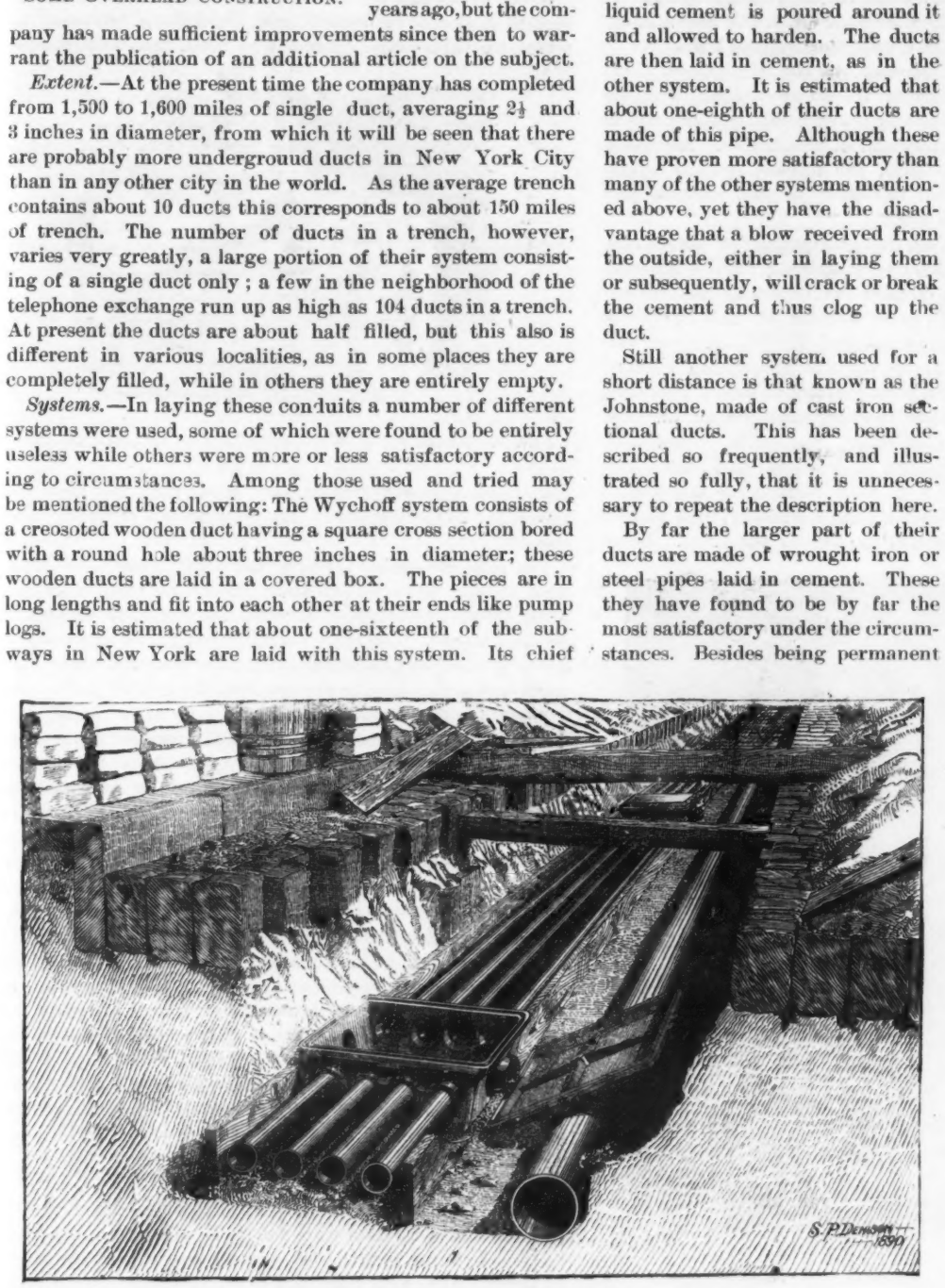


FIG. 1.—CONSTRUCTION OF A NEW YORK SUBWAY.

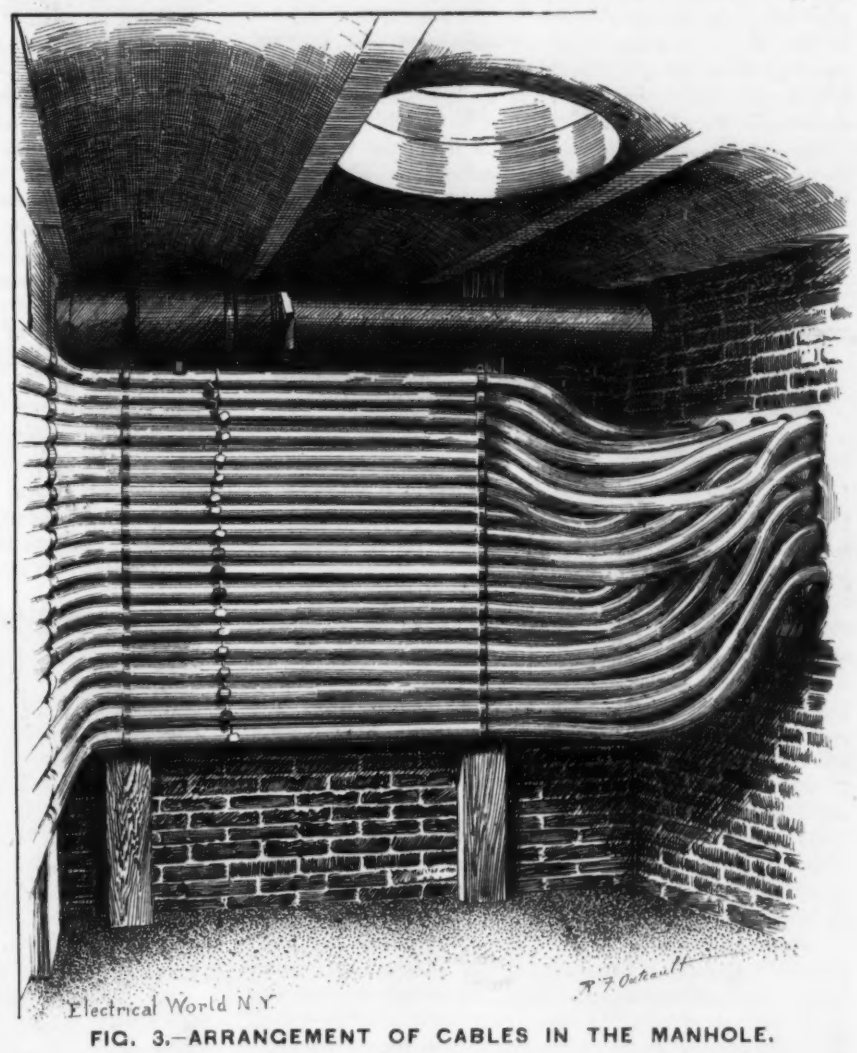


FIG. 3.—ARRANGEMENT OF CABLES IN THE MANHOLE.

The ducts for the high tension electric light service are all entirely separate from the telegraph and telephone cables; as a rule they have not even the manholes in common, thus making two entirely independent systems. The lower ducts are used as trunk lines, while the upper ones form what they call their distributing system. In the latter the distributing boxes are placed opposite every party wall and have branch openings through which house connections can be made with any of the cables in those ducts. These are covered with double iron covers and are within 16 to 18 inches below the surface of the street. They are kept under lock and key, and are accessible only in the presence of one of the company's authorized workmen.

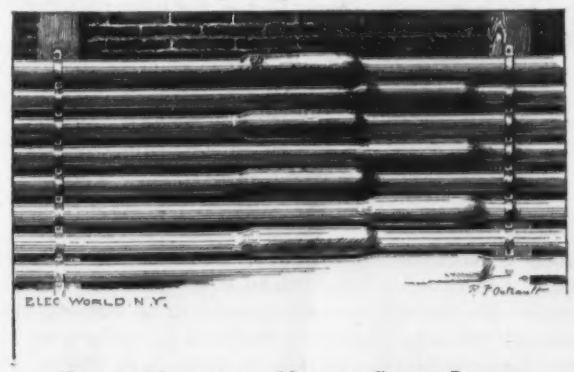


FIG. 4.—METHOD OF MAKING CABLE JOINTS.

Especial attention is given to the concrete used. Their specifications call for two parts of sharp sand, preferably what is known as Cow Bay sand, and one part of cement; the coarse pebble sand is used for the subways, while the

fine sand only is used in the brickwork. Some idea of the amount of brickwork which they have to construct will be seen from the fact that in one year they used over 2,000,000 bricks.

Some of the implements used in drawing the cables through the ducts are shown in the accompanying figures. For this work they use the well-known system of coupling rods together, and pushing these through the ducts until communication is established between two manholes. To this rod is then attached the rope with which the cable is afterward drawn through. After a long and varied experience they have found the coupling shown in Fig. 5 to be the most suitable. It is made of brass, secured to the ends of the wooden rods. By means of it the rods are coupled in much less time than it would take to screw them together as formerly, and it is quite impossible for the joint to uncouple itself in the duct. Fig. 6 shows what may be called a round chisel which they use to clean out obstructions which may have been formed within the duct. It consists, as shown, of a steel cap having a chisel edge which is connected by means of a loose link to the end of the rod; by working this rod backward and forward repeated blows are given to this cap. Holes have even been drilled with this device where the conduit was found almost closed up. Fig. 7 shows the method of attaching the rope to the end of a composite cable. The iron loop is secured to the cable with ordinary wood screws, which are just long enough to enter the lead sheath on the opposite side.

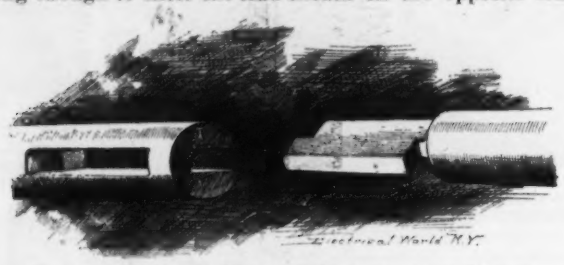


Fig. 5.—Coupling Used in Drawing in Cables.

It has been found that they do not cut the copper wires, and as this end must be bared for a coupling in all cases, no portion of the cable is injured.

In digging the trenches a number of curious relics were found buried in the streets, which now form quite an interesting little museum. Among these was an old wooden water pipe laid in the year 1800, of which Fig. 8 shows a joint and Fig. 9 a valve. The wood of this pipe was found in a remarkably good state of preservation. Among other relics may be mentioned a peculiar form of grape shot, shown in Fig. 10, also a number of shells and other historical relics of a like nature.

Operation.—In the maintenance of the subways the accumulation of gas in the manholes has been found a great source of trouble and danger. At first the explosions were so frequent that they caused considerable complaints, but at present they have succeeded in overcoming this completely by forcing air from the stations, through a regular system of distributing pipes, into all the different manholes. In the present system 12 blowers are used, each of which has a capacity of about 15,000 cubic feet per minute, at a pressure of from six to seven ounces. These blowers are located at the various stations, and carry air to a distance of over a mile. The cost of maintenance of this part of the plant alone is said to be $40,000 a year. In each manhole the air is allowed to escape from these distributing pipes through a crude sort of valve, by means of which it can be regulated so that the more distant manholes will receive their proper proportion. Although the pipes are quite tight, it has been found practically impossible to keep the manholes so tight that gas will not enter. At first the air was forced through the ducts themselves, but this was found unsatisfactory, so that a complete system of air supply pipes is now used.

The manholes are kept under lock and key. The only access that can be obtained to them is through an authorized agent of the company, who remains present as long as the hole is left open. Some idea of the force required will be had from the fact that the company sometimes has as

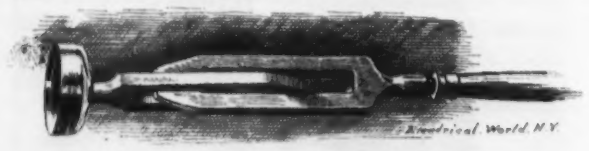


Fig. 6.—Tool for Cleaning out Ducts.

many as 300 applications a day. Burn outs are very rare, those that do occur being chiefly at the joints in the manholes. Electrically, the system seems to be perfectly satisfactory; the only objections made to it are the great cost and the great delay in making the changes or repairs.

Cost.—It appears to be quite impossible to obtain even an average figure for the cost of these subways, partly because the cost varied so very greatly in different parts of the city. It has been estimated, however, by a presumably reliable authority that the average is about $5,000 a mile. It is stated by the company to be as high as $20,000 per mile per single duct in cases where very good pavement is used and where flush boxes have to be inserted leading to the surface of the pavement to prevent having to dig up the streets. This figure amounts to about $4 a foot, which is more than it costs to build some railroads. The lowest figure given by them is about 15 cents a foot or about $800 a mile. This is for a wooden duct in trenches containing at least 12 ducts. Both of these prices include everything. A certain authority, not connected with the company, states that the ducts ought not to cost more than $3,000 per mile per duct. But assuming $5,000 as the cost, a total of 1,550 miles represents an outlay of $7,750,000. The average cost of a manhole is $250. But this also varies between very wide limits.

Fig. 7.—Method of Attaching a Rope to the End of a Cable.

Charges.—The rentals charged for these ducts are as follows:

$1,000 per mile per 3-inch duct, for the distributing system.

$900 per mile per 3-inch duct, for the trunk lines.

$850 per mile per 2½-inch duct for the trunk lines.

$730 per mile per 2-inch duct, for the trunk lines.

$550 per mile per 1¼-inch duct, for the trunk lines.

Unfortunately these prices are so very high that for electric lighting in which only a few cables can be laid in one duct the price becomes almost prohibitive. Assuming the average rental as $850, the annual income would amount to almost one and one-third million dollars, provided the ducts were all filled.

Location Records.—With the multiplicity of cables now in the subways it would be very difficult for the different companies to keep track of their own cables unless a minute and careful record of the exact position of each cable was kept. A very satisfactory method for this purpose has been devised by Mr. Leslie for the Manhattan Electric Light Company. A field book contains an exact reproduction of the ends of the ducts in every manhole on the line, both where they leave and enter, the ducts occupied by that company being marked or lettered, and also a side elevation of all the cables in each duct from manhole to manhole. Each cable bears a certain number, and carries this number from one end of the line to the other. These

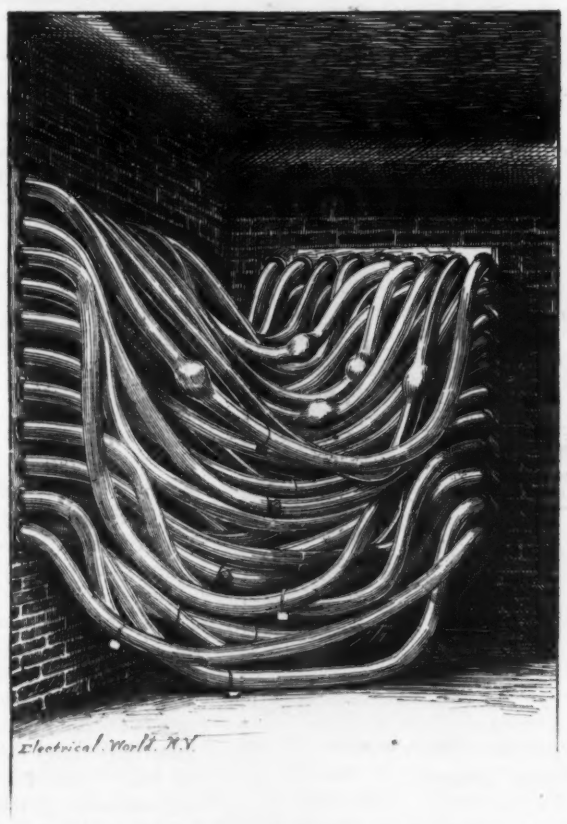


Fig. 2.—Arrangement of Cables in one of the Older Manholes.

numbers are indicated by tags at each manhole and are never changed, although the number of the circuit may change from time to time or vary at different parts of the line, as recorded in the field book. This corresponds to the plan kept of overhead circuits, and although the wires are not visible to the eye, the record is as complete and reference to any particular wire as easy, as in that system.

Organization.—The various organizations controlling these subways appear to have very complicated relations. It will suffice here to say that the Board of Electrical Control, which is a State board, decides where the subways are to go and how many are to be built. The two companies which control the present system are the Empire City Subway Company, Limited, which has charge of all the low tension ducts, and the Consolidated Telegraph and Electric Subway Company, which has charge of the high tension ducts. These two companies simply build, rent and maintain the ducts.

Fig. 8.—Relic of a Water Pipe Joint Laid in 1800.

The building of a subway on a new street is a matter which rests entirely with the board of Electrical Control. The board having decided, either from the applications of individual companies or the general demand, that a subway is needed, notify the Subway company to that effect, and furnish them with information as to how many ducts are wanted for immediate use and how many will probably be required in the future. The subway is then constructed by that company and maintained by it. The various light and telephone companies apply through the board for the use of as many ducts as they desire, pay as rental a certain sum per annum, and insert and maintain their own cables, under the supervision, however, of both the board and the Subway company.

The First Central Station Operated by the Three-Phase Current.

Some weeks ago we mentioned in our columns that the central station at Heilbronn, near Heidelberg, Germany, in which the three-phase current was used, had been started

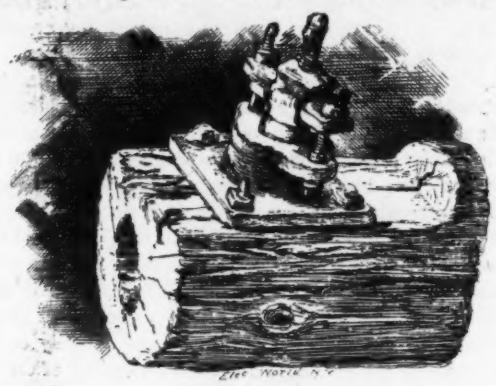


Fig. 9.—Relic of a Water Pipe Valve Laid in 1800.

and was in successful operation. Since then we have obtained the following additional information regarding this station.

The primary station is in the town of Lauffen, 15 kilowatts (about nine miles) from Heilbronn, the machines being driven by water power. When the station is completely finished there will be three turbines and three dynamos of 300 h. p. each; at present there is but one running. This generator is the same as the one which was used in the now famous Lauffen-Frankfort transmission experiment, and was fully described in our columns. It generates three alternating currents of 50 volts, differing in phase by 120 degrees. The current at the primary station is transformed by one of Dobrowolsky's three-phase current transformers up to 5,000 volts and is led to Heilbronn by air lines on poles.

At the secondary station it is reduced by a step-down transformer to 150 volts, the three currents from which are led through cables containing three concentric conductors in which it is distributed throughout the city. At numerous points it is transformed in small sub-stations down to 100 volts. This low tension network of circuits is a single unit throughout the whole city, corresponding to three potential plates; all the transformers therefore work in parallel and equalize the load among themselves. The smallest local transformer has a capacity of about five kilowatts, and the largest 15 kilowatts. A number of Dobrowolsky motors are in use, being run from the 100-volt mains. Arc lamps are used in numerous places, being run three in series on 100 volts.

Much interest has been shown in this installation, as it is the first one of its kind ever built. It will, therefore, be of interest to know that it is at present working quite satisfactorily. Although Tesla was the first to develop the multiphase system here in America, it is strange that the first central station operated in this way should have been built in a small town in Germany.

The large transformers at Heilbronn were made by the

Fig. 10.—Grapeshot Dug up in Subway Excavation.

Oerlikon Company, of Zurich, under the Dobrowolsky patents. The motors were built in Berlin under the direct supervision of the inventor.

A Canadian Niagara Power Company.

A bill has been introduced in the Legislature of Ontario which will create the Canadian Niagara Power Company and give to that company the exclusive privilege to develop the power of the falls on the Canadian side of the river. The company undertakes to begin work May 1, 1897, and on Nov. 1, 1898, to have completed water connections for 25,000 h. p., and have 10,000 h. p. ready for use.

Application of the Weston Voltmeters and Ammeters to Practical Electrical Measurements.—V.

BY H. MASCHKE, PH. D.

§ 29. *Measuring Incandescent Lamps.*—To measure the electrical constants of incandescent lamps, as is necessary in making photometric tests, the following arrangement may be used (see Fig. 40). Let A and B be the terminals of the incandescent lamp, and let a known resistance of 1 ohm be inserted between B and C, in series with the lamp. The points A, B and C are connected with the terminals of the switch shown in the figure, the contacts on the opposite side of the switch being connected to the double scale voltmeter as shown. If the contact levers are moved to the left, as shown, the pressure V existing at the terminals of the incandescent lamp is read in volts on the upper scale; if they are moved to the right the strength of the current C passing through the lamp is read in ampères on the lower scale (see Sec. 19). The resistance of the lamp, while burning, is then

$$r_1 = \frac{V}{C} \text{ ohms.}$$

If for instance $V = 110.5$ volts, $C = 0.57$ ampère, it follows that

$$r_1 = \frac{110.5}{0.57} = 194 \text{ ohms.}$$

In this case the voltage is measured exact to about $\frac{1}{10}$ of

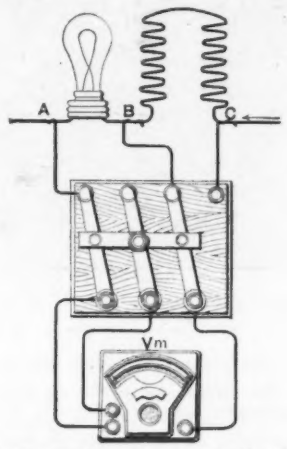


FIG. 40.—MEASURING INCANDESCENT LAMP CONSTANTS.

a volt, the current strength to about $\frac{1}{500}$ ampère and the resistance to about 1 ohm.

§ 30. *Measuring Arc Lamps and Arc Lamp Circuits.*—For measuring the potential difference between the poles of an arc lamp, the voltmeter (0 to 150 volts) is attached to the terminals of the lamp (Fig. 41).

In case several lamps are joined in series, the number of lamps burning may be found out by measuring the voltage at the ends of the entire circuit. If, for instance, each lamp requires 45 volts, while the drop of potential in the leads amounts to 20 volts, and if the voltage at the poles of the dynamo is 970 volts, the number of lamps burning would be

$$\frac{970 - 20}{45} = 21.1,$$

which practically means that 21 lamps are burning. Special voltmeters are constructed so as to enable one to read directly on the scale the number of burning lamps as well as the total voltage.

If there should happen to be a ground leak in an arc light circuit the following method will enable one at the station to locate it and to measure its resistance.

The circuit shown by Fig. 42 contains 26 arc lamps.

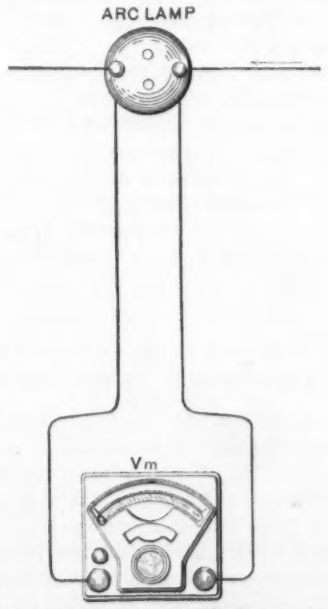


FIG. 41.—MEASURING THE E. M. F. OF ARC LAMPS.

Suppose the ground leak to be located at C, between lamp No. x (counting from A) and the following one, and to have a resistance of r_1 ohms. With the contact keys K and K_1, either terminal of the voltmeter (ranging from 0–1,500 volts) may be connected to the earth G. First connect K with P and K_1 with Q_1. The voltmeter is then connected with A and through the ground connection to C. The potential difference between A and C is $45 \times x$ volts, if each lamp requires 45 volts. Since, however, the resistance r_1 is in series with the resistance r of the voltmeter, the deflection V_1 of the latter will indicate

$$V_1 = \frac{r}{r + r_1} \times 45\ x \text{ volts.}$$

Now connect K to Q and K_1 to P_1. The voltmeter is

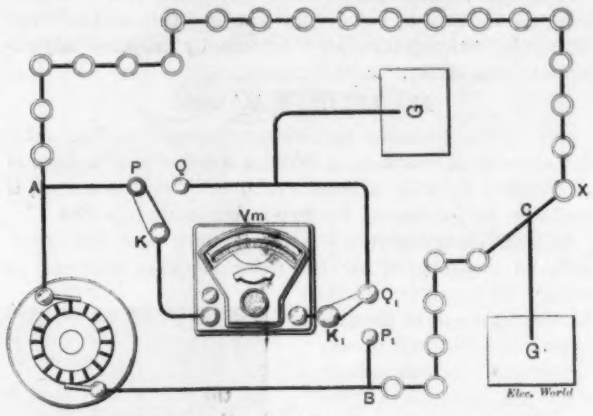


FIG. 42.—MEASURING THE E. M. F. OF ARC LAMPS.

then connected in series with the resistance r_1, to the points B and C of the circuit, the potential difference of which is

$$(26 - x) \times 45 \text{ volts.}$$

The indication of the voltmeter will then be

$$V_2 = \frac{r}{+r r_1} (26 - x) \times 45 \text{ volts.}$$

We therefore find

$$\frac{V_1}{V_2} = \frac{x}{26 - x},$$

or

$$x = 26 \frac{V_1}{V_1 + V_2}.$$

If, for instance, $V_1 = 200$, $V_2 = 60$, then

$$x = 26 \times \frac{200}{260} = 20.$$

This would show that the ground was located between the twentieth and twenty-first lamps, counting from A.

From the equation given above

$$V_1 = \frac{r}{r + r_1} \times 45\ x,$$

we can find the numerical value of r_1, viz.:

$$r_1 = \frac{r}{V_1} (45\ x - V_1).$$

In the example we had $V_1 = 200$ and $x = 20$. If therefore the resistance r of the voltmeter was 145,000 ohms, we find the resistance of the ground leak to be

$$r_1 = \frac{145{,}000}{200} (900 - 200) = 507{,}500 \text{ ohms.}$$

By this method it is possible to measure resistances of

FIG. 43.—A MISUSED INSTRUMENT.

15 megohms exact to about 10 per cent. as far as the admissible error in the readings of the voltmeter is concerned.

§ 31. *Testing the Magnetic Leakage in Dynamos and Motors.*—In an article in this journal of Jan. 2, 1892, Mr. Ives describes a new and very important application of the Weston voltmeters. He found that by utilizing a Weston voltmeter, the magnetic leakage of a dynamo can be measured with the same exactness as by using a ballistic galvanometer. The experiments were repeated in the laboratory of the Weston Electrical Instrument Company, in order to find out what kind of a Weston instrument was best adapted for this purpose. Referring to the above mentioned article, as far as particulars are concerned, we give herewith a brief description of the method and the best conditions of the test,

One turn of wire is wound around that part of the dynamo which is to be tested, for instance around one of the field coils, and is connected is series with a Weston millivoltmeter, ranging from 0 to 0.040 volt. The brushes are taken off the commutator so as to disconnect the armature, and a current of about the same strength is sent through the field as the one that is ordinarily used when running the machine. Under these circumstances, a certain amount of lines of force is flowing through the single wire loop of the secondary circuit. Upon breaking now the primary current flowing through the field, all these lines of force will vanish, causing thereby a certain E. M. F. and a transient current in the secondary circuit. This current will produce a certain deflection of the pointer of the millivoltmeter, for instance .035 volt. If now, the secondary single wire loop is wound around the armature and the same test repeated, another deflection will be observed on the millivoltmeter, for instance .029 volt. Consequently the number of lines flowing through the armature is less by $100 \times \frac{(0.035 - 0.029)}{0.035} = 17.2$ per cent. than the one wound around the field coil; 17.2 per cent. of the originally created lines of force are lost, or in other words, the magnetic leakage of the machineamountsto 17.2 per cent.

In the same way other parts of the machine may be tested, the difference of two readings always showing the leakage between the two places tested with the secondary coil. The leakage may also be determined directly by holding the secondary coil against the surface through which it takes place.

Especially in the latter case it is sometimes desirable to have a higher sensibility, the deflection of the pointer being perhaps too small. In order to secure this it is only necessary to take two or more turns of wire for the secondary coil, instead of one. The readings are then to be divided by the number of turns in order to compare them with those taken by a single wire coil.

It is very important for making fair comparison to have always the same amount of resistance in the secondary circuit. If, therefore, different readings are to be made with a different number of turns, it is necessary to use always the same amount of wire in the secondary circuit, by choosing the wire so long as to be sufficient for the maxi-

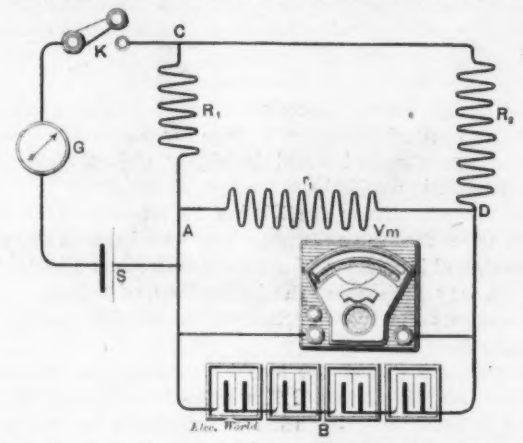


FIG. 44.—STANDARDIZING THE WESTON VOLTMETERS.

mum number of turns. As the resistance of the millivoltmeter itself is very low, it is advisable to take the wire thick enough to keep the total resistance low.

If the deflections of the millivoltmeter should happen to surpass the range of the instrument, a suitable resistance is to be inserted in the secondary circuit in order to reduce the sensibility.

The E. M. F. induced in the secondary by breaking the primary circuit depends upon the suddenness of the break, *i. e.*, upon the duration of the spark.

In order to secure the same conditions for all tests, it is advisable to supply the breaking device with a spring, so that the rapidity of breaking the current is always the same. Besides this, a suitable ammeter should be inserted into the primary circuit, to make sure to have always one and the same current strength.

§ 32. *Precautions to be Observed in Using the Weston Instruments.*—As mentioned before (Sec. 6) it is advisable to avoid violent shaking of the instruments, since the pivots and jeweled bearings of the movable coil might thereby be damaged.

The influence of magnetic fields upon the instruments is objectionable only if the fields are very strong and if the instrument happens to come into close proximity with them. A Weston shunt dynamo of medium size running with a voltage of 130 volts hardly affected the readings at a distance of three feet, while at a distance of five feet no effect whatever could be noticed. To be perfectly safe, it is advisable not to place the instrument in the immediate neighborhood of dynamos or heavy currents on switchboards.

The instrument should be placed *approximately horizontal* when measurements are to be made. In case a small inclination is desirable, this inclination should never be so large that the pointer deviates from the zero point when the instrument is not in circuit. If the instrument is used at an inclination, the friction in the bearings may be slightly increased, thus impairing the accuracy of the indications. *Large masses of iron should be avoided* in close proximity to the instrument, and it should never be placed

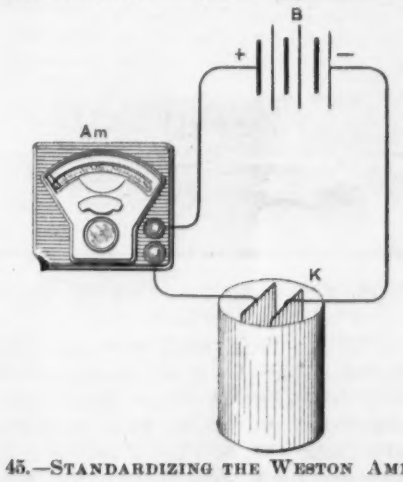


FIG. 45.—STANDARDIZING THE WESTON AMMETER.

on top of a dynamo, running or idle, on steam chests, steam pipes, iron steam radiators, bus-bars, etc. Anything of that kind will not affect the magnet permanently, but it will change the reading of the instrument for the time being. Neither should the instrument be put in a hot place, since this might melt off the paraffine insulation on th resistance coil. If the instrument is to be fastened down, brass screws should be used, and not iron nails or spikes (all cases which come within the actual experience of the manufacturers).

In making connections for the voltmeter, *thin flexible wire*, well insulated, should always be used, and proper care taken that no *short circuit* is made through the *metal case* (an accident happening rather often through carelessness of the user) *by touching it with the bare ends of the two pressure wires.* A very instructive case of such a short circuit is shown in Fig. 43. Contact was evidently made at the two corners of the metal case with the pressure wires of a 600-volt circuit. As a consequence, the metal case was partly destroyed, the binding posts burned off, and the wooden base badly scorched. It might be of interest to mention that, nevertheless, the moving part of the instrument was still in working order.

Wiping the glass cover before making a reading should be avoided. Neglect of this rule frequently causes great discrepancies in the readings of electrical measuring instruments; the very light aluminium pointer of the instrument being affected by the static charge of the glass, electrified by wiping with a dry cloth or chamois skin.

Finally, it is scarcely necessary to mention, that to exceed the upper limit of current or voltage for which the instruments are constructed would be highly objectionable and must be strictly avoided.

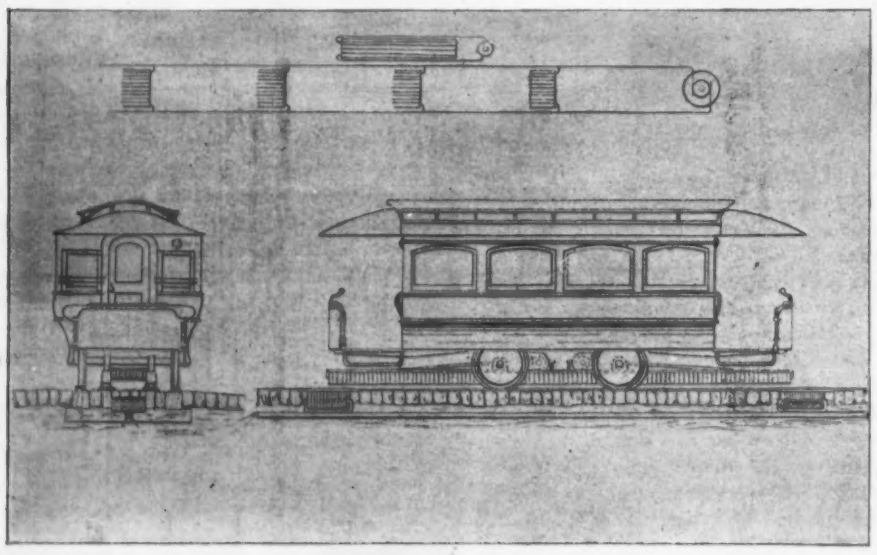
§ 33. *Standardizing the Weston Voltmeters.*—If a suspicion arises that the apparatus has been injured by some accident, and if another Weston voltmeter is available, the simplest way of checking the indications, of course, would be to connect the two instruments in multiple arc and to compare their readings.

In case the scales of the two instruments are different, they may still be compared if a suitable resistance be connected in series with the instrument designed for the lower voltages, so as to make the sensitiveness of both instruments alike. (For the calculation of such additional resistance, see Sec. 14.)

A No. 3 voltmeter (see Sec. 11), or a voltmeter supplied with a calibrating coil, may be checked very easily by connecting it with the poles of a cell of known and constant E. M. F. (Daniell cell, Callaud cell, etc.). If the deflection produced by such E. M. F. has once been noted, it is evident that it may be used as a check for all future occasions. Elements of a very high resistance (as Clark's cells and similar standard cells) must not be used for this purpose on account of their rapid polarization even when made to give a very small current.

If a more accurate calibration is desired, independent of the indications of other instruments, a modification of the methods explained in Sec. 16 may advantageously be applied in the following way:

Suppose the range of the voltmeter to be from 0 to 150 volts. Let B (Fig. 44) be a current generator of constant E. M. F., capable of producing between A and D a potential difference E up to 150 volts. Let r_1 be a resistance serving to regulate the actual amount of potential difference between A and D. To these points are connected the terminals of the voltmeter as well as a shunt containing the resistances R_1 and R_2. Another shunt containing a standard cell S of known E. M. F., a mirror or other sensitive galvanometer G and a key K are connected to the ends A and C of the resistance R_1. The pole of the standard cell connected to A must be of the same polarity as the pole of B, which is connected to A.



FIGS. 1, 2 AND 3.—DEWEY'S CONDUIT RAILWAY SYSTEM.

The resistances R_1 and R_2 must now be adjusted in such a way that, upon closing K, no deflection of G is obtained. When this is the case, the proportion between the electromotive forces E and S will be $E : S = R_1 + R_2 : R_1$, or

$$E = \frac{R_1 + R_2}{R_1} \times S$$

For instance, let S be a Clark cell having at the existing temperature an E. M. F. of 1.45 volts. Let $R_1 = 145$ ohms and $R_2 = 9{,}737$ ohms be the resistances with which no deflection was obtained in the galvanometer G. Then

$$E = \frac{9{,}737 + 145}{145} \times 1.45 = 98.82 \text{ volts.}$$

It is most convenient to make $R_1 = 100 \times S$ ohms, S being the number of volts of the standard cell, and to bring the current passing through G to zero by properly adjusting the value of R_2. In that case

$$E = 0.01\,(R_1 + R_2) \text{ volts.}$$

§ 34. *Standardizing the Weston Ammeters.*—The most obvious way of checking a Weston ammeter, of course, is to compare it with a similar and reliable instrument, if available, by joining up the two instruments in series.

As with the voltmeters, the instruments need not necessarily be constructed for the same range of current. It suffices to properly reduce the sensitiveness of the ammeter designed for lower currents by applying a shunt of suitable resistance. (For the calculation of this shunt see Sec. 20.)

Since current strengths may also be measured with the voltmeter (see Sec. 19), an ammeter may also be standardized by means of a reliable voltmeter. The terminals of the voltmeter are then connected to the terminals of a suitable and known resistance inserted in the circuit of the ammeter. The calibration can then be readily accomplished.

Of course the same method could serve inversely to calibrate a voltmeter by means of a reliable ammeter.

Another reliable way of calibrating an ammeter, independently of the indications of other instruments, is to connect it up in series with a constant current generator B and a copper or silver voltameter (see Fig. 45). The cathode K, that is the plate on which the metal is deposited, is to be connected with the negative pole of B. Since a current of one ampère passing for one minute deposits 0.304 grain of copper and 1.035 grains of silver, the strength C of the current used may easily be determined by the increase M in weight of the cathode. If M is also measured in grains, and if the current was passing through the voltameter during t minutes, then

$$C = \frac{M}{c \times t} \text{ ampères.}$$

c being 0.304 if the copper voltameter, and 1.035 if the silver voltameter is used.

If for example $M = 7.25$ grains, $t = 30$ minutes, there will be in case of a copper voltameter:

$$C = \frac{7.25}{0.304 \times 30} = 0.794 \text{ ampère.}$$

§ 35. *Calibrating Other Voltmeters and Ammeters with the Weston Standard Instruments.*—From the two foregoing sections it is evident how any other instruments may be calibrated by means of the Weston apparatus.

No better and more encouraging proof of the great satisfaction derived from these instruments could possibly be afforded than the general application which they have found all over the field of electrical industries as reliable and accurate standards.

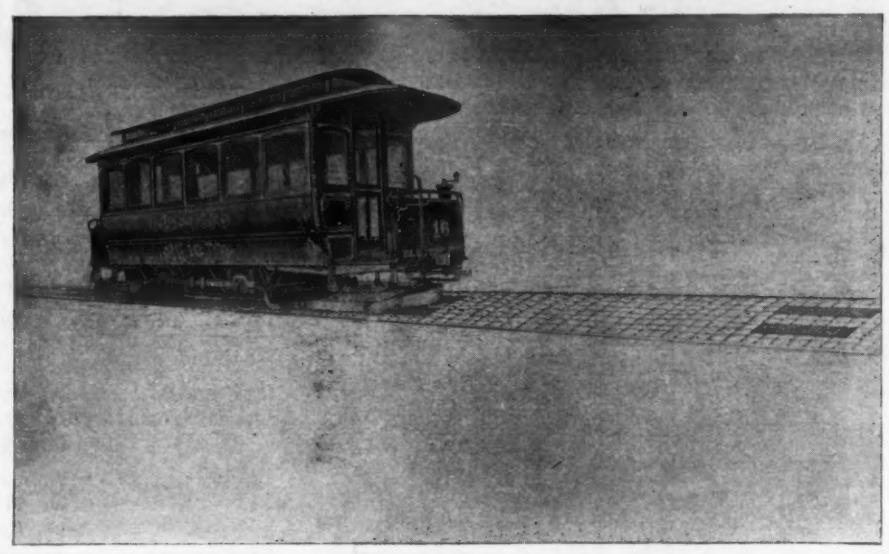


FIG. 4.—DEWEY'S CONDUIT RAILWAY SYSTEM.

The Dewey Closed Conduit Electric Railway System.

Ever since the advent of the electric railway inventors have been endeavoring to devise some system for propelling cars in which the current could be transmitted to the car by induction; in other words, a system which would not require an overhead construction, but which would at the same time receive its current directly from the power station. It was also desired that this system should not require a slotted conduit, that it would allow a high voltage to be used without danger and that it should not be necessary to carry storage batteries on the cars. A number of attempts have been made to solve this problem and systems have been brought out for which some or all of these advantages were claimed.

A patent has just been granted to Mark W. Dewey for an induction system which seems to possess a number of good features, and which is worthy of the attention of electric railway managers. The accompanying illustrations show the details of Mr. Dewey's system. The principle upon which this system is based is that of induction, the arrangement of the transformers being such that the primary circuit is underneath the road bed, while the secondary is carried upon the car, so that there is no metallic connection between the car and the main circuit from which the current is derived. The car therefore has no direct connection with the line conductor. In applying this principle use is preferably made of the fact that the presence of a complete or nearly complete magnetic circuit in or around the primary and secondary circuits greatly increases the inductive effects of the primary current, a feature of construction already recognized and applied in transformers and converters now in use in alternating current systems of electric lighting. The elements of this magnetic circuit are constructed in two parts, one of which is stationary, as mentioned above, and is embedded in the roadway, the other part being carried upon the car. The stationary part is energized by a pulsating or alternating current from any suitable source, the induced current being generated in one or more coils surrounding the movable part of the magnetic circuit. The current thus generated may be transmitted directly to one or more suitable motors arranged to drive the car, or, if desired, it may be rectified before it is carried to the motors. The movable part of the transformer on the car is continually in inductive relation to one or more of the stationary parts of the converter.

Many different mechanical constructions may be used in carrying out such a method, but the inventor considers the preferable and most effective plan to be that of placing the coils wound upon ⊔-shaped iron cores in the roadbed between the rails, at equal distances apart and at intervals corresponding to the length of the car. The two ends of the car are placed on a level with the pavement or slightly above it. Roughened iron wearing plates may be secured by suitable means to the ends of the cores so that the cores themselves will not be worn. These plates may be removed when necessary and others substituted. The conductor extending to the coils is thoroughly insulated and laid under ground along the railway.

The apparatus carried upon the car constitutes the other half of the transformer. Each motor has an inverted ⊔-shaped or straight iron core, upon which one or more secondary coils are wound. The ends of this core should come directly above and in close proximity to the ends of the roadbed cores. If the complete magnetic circuit is to be maintained by the cores the vehicle cores should be somewhat longer than the distance between the roadbed cores, and iron brushes or wheels should be secured to the ends of the vehicle core to make contact with the stationary cores. By this arrangement the energy for lighting and heating the car as well as propelling it is supplied. These cores may be laminated and the windings on them would of course be suited to the amount of current to be used and the transformation required for the motors employed in any particular case.

The vehicle coil core may be mounted upon the axles or truck of the vehicle, or may be mounted independently upon wheels to travel either on the same rails that the vehicle travels on, or one or more separate rails laid between the others.

The Fate of a "Yaller" Dog.

Once there was a man who had a "yaller" dog. The dog himself felt very big, but he was really no bigger than common dogs, if as big, but that made no difference; he was great at barking, and when there was nothing near his size to bark at he would squat on his haunches and bark at the moon by the hour. But the moon kept right along just as if there never was a "yaller" dog. This made the "yaller" dog very mad and he tried to jump to the moon, but he fell short and the moon kept right along just the same. At last, the "yaller" dog died from sheer barking and jumping, and the man who owned him has never had a "yaller" dog since. The moral of this Yankee story is in its application; whenever you see a paper whose chief business is "barking" at bigger papers "that keep right along," just think what became of the "yaller" dog that made barking at the moon his chief work. The dog died, and no one was sorry, but "the moon kept right along just the same."—*London Electrical Review.*

The Present Limitations of Electric Power in Mining.—II.*

BY IRVING HALE.

Fig. 1 is drawn from equations *B* and *C*. Equation (*B*) gives a straight line, the same for all voltages. Equation (C^1) gives a separate curve for each voltage. The horizontal 23 per cent. line cuts these curves at points beyond which minimum cost must be sacrificed and line drop maintained at 23 per cent. of dynamo voltage. It takes the place of a curve plotted from equation (*D*).

The curves at top of Fig. 1 show total efficiency of "minimum cost" plants using various voltages, and at all distances up to 100,000 feet. Each of these curves is plotted from the corresponding curve *C'* (line loss) by multiplying product of dynamo and motor efficiencies (.90 × .80) by unity less line loss for the distance considered. The total efficiency corresponding to the assumed maximum line loss, 23 per cent., is .90 × .80 × .77 = 55.4 per cent. Beyond this point the efficiency curve for "minimum cost" is broken, while the full horizontal line at 55.4 per cent. becomes the efficiency curve of the plant having "lowest practicable cost."

The total efficiency curves for double conversion plan ts might be plotted on the same figure, for comparison of the efficiencies obtained with the two methods, but as this

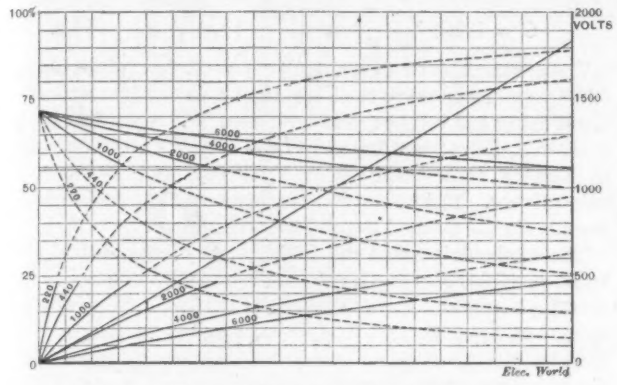


FIG. 1.—TRANSMISSION OF POWER CURVES.

Straight line shows volts lost for minimum cost. Curves convex upward show percentage lost (in terms of dynamo voltage) for minimum cost. The horizontal line at 23 per cent. shows assumed maximum allowable loss. Curves convex downward show corresponding commercial efficiency of plant. The horizontal line at 55.4 per cent. shows commercial efficiency, corresponding to maximum allowable line loss, 23 per cent. Figures on right (volts) apply to straight line. Figures on left (percentages) apply to curves.

would cause considerable confusion it has not been done. As will be shown hereafter, the efficiency with double conversion is much lower than with direct transmission.

The curves in Figs. 2 to 5 are plotted from equations (1) and (1 *a*) assuming various sizes of plants and voltages, a separate figure being drawn for each size of plant to avoid confusion. Equation (1), "minimum cost of plant," gives a straight line which is drawn full up to the point determined by equation (*D*), beyond which minimum cost must be abandoned in order to keep the line loss within practicable limits. Beyond this point the line is broken. At this point begins the curve plotted from equation (1 *a*) and representing "lowest practicable cost of plant."

The lowest curve in the 1,000 h. p. diagram (Fig. 5) shows cost of plant, exclusive of wire, and assuming dynamos of same size as motors (line loss zero). It represents the limit which may be approached by increasing the voltage, but which can never be reached, no matter how high a voltage may be employed. The only hope of decreasing cost below this lies in cheapening the machinery itself.

OPERATING EXPENSES.

The operating expenses of an electric plant may be divided into two parts. The first, consisting of labor, superintendence, oil and incidentals, will be practically independent of cost of the plant for a fixed amount of power delivered. The second, consisting of depreciation and repairs, taxes, insurance and interest on investment, will be nearly proportional to cost.

In the following estimate, interest is placed at 20 per cent. per annum. This is not too high, partly for the reason that interest rates are high in mining districts, but principally because mining is an uncertain and fluctuating business, and a company putting in an expensive plant of machinery can never tell how much use can be obtained from it before a change in the outlook makes it necessary to shut it down or move it, or replace it by other machinery better adapted to the changing conditions. For these reasons no mining man would think of investing in machinery unless it would pay for itself in five years, and many would not touch it even with that guarantee. For similar reasons, and also because mining machinery is operated under trying conditions, the item of depreciation and repairs is made a little higher than the amount usually allowed.

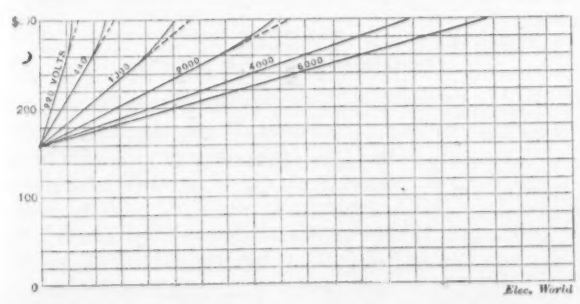


FIG. 2 (100 H. P.).—TRANSMISSION OF POWER CURVES.

Figures on the left show minimum total cost of plant per horse power on motor pulley. The horizontal scale represents distance in feet, each space representing 5,000 feet. The straight lines show minimum cost, and the curved portions show lowest practicable cost (line loss 23 per cent. of dynamo voltage).

In plants of 100-h. p. and 200-h. p. capacity, no provision is made for superintendence or general expenses, as it is assumed that a plant of that size would be run by a mining company for its own use, and be in charge of its regular superintendent. Plants of 500 h. p. and upward are assumed to be run by an independent company for rental of power, and to require superintendent, electrician, and other general expenses.

This accounts for the fact that the operating expense per horse power for a 500-h. p. plant running 10 hours a day is a little greater than for a 200-h. p. plant.

In case of plants renting power to consumers, the motors and men to run them would generally be furnished by the user of power, but these expenses are included in order to make a comparison with steam. In making this comparison it is assumed that power is used in units of 100 h. p. This assumption favors steam, because usually the power would be used in smaller units, in which case the increased cost of attendance and labor would be greater with steam than with electricity, as small motors can frequently be given the required attention by men engaged at other work.

ANNUAL OPERATING EXPENSES OF ELECTRIC PLANT.

	10 hours per day.	24 hours per day.
100-H. P. Plant.		
Dynamo tender	$1,500	.....
Chief dynamo tender and two assistants	.....	$3,900
Lineman and general assistant	1,200	1,200
Motor tender (proportional part of wages of man engaged in other work)	600	1,800
Oil, waste, incidentals	200	400
Expenses independent of cost	$3,500	$7,300
Per horse power	$35	$73
Depreciation and repairs	6 per cent.	10 per cent.
Insurance and taxes	1 " "	1 " "
Interest and taxes	20 " "	20 " "
Expenses depending on cost	27 per cent.	31 per cent.
200-H. P. Plant.		
Dynamo tenders	(1) $1,500	(3) $3,900
Lineman and general assistant	1,200	1,200
Oil, waste and incidentals	300	600
Motor tenders (motors in different places and requiring part of time of two men)	1,200	3,600
Expenses independent of cost	$4,200	$9,300
Per horse power	$21	$46.50
Depreciation, repairs, taxes, interest and insurance	27 per cent.	31 per cent.
500-H. P. Plant.		
Superintendent and electrician	$3,000	$3,000
Bookkeeper	1,500	1,500
Armature winder and mechanic	1,500	1,500
Lineman	1,200	1,200
Dynamo tender	(1) 1,500	(3) 3,900
Motor tenders (supposing five 100-h. p motors in different places, requiring partial services of five men)	3,000	9,000
Oil, waste and incidentals	600	1,200
Expenses independent of cost	$12,300	$21,300
Per horse power	$24.60	$42.60
*Depreciation, repairs, taxes, insurance and interest	25 per cent.	38 per cent.
1,000-H. P. Plant.		
Superintendent and electrician	$3,600	$3,600
Bookkeeper	1,500	1,500
Armature winder and mechanic	1,800	1,800
Two linemen and general assistants	2,400	2,400
Dynamo tenders	(1) 1,800	(3) 4,800
Motor tenders (part services of 10 men)	6,000	18,000
Oil, waste and incidentals	1,000	2,000
Expenses independent of cost	$18,100	$34,100
Per horse power	$18.10	$34.10
Depreciation, repairs, taxes, insurance and interest	25 per cent.	28 per cent.

As the operating expenses per horse power of a plant of certain size consists of two parts, one independent of and the other directly proportional to the cost of the plant, the curve of expense can be drawn by laying off on the axis of expense a distance representing the part independent of cost and drawing a straight line, making with the axis of cost an angle whose tangent is equal to the amount of depreciation, repairs, taxes, insurance and interest, expressed as a fractional part of cost. The curves in Fig. 6 are plotted in this manner. For example, the total annual operating expenses per horse power of a 500-h. p. plant costing $220 per horse power would be $79 if run 10 hours per day, and $105 if run 24 hours per day. By joining Fig. 2 and Fig. 1 so as to make the axis of cost of plant the same for each, the two figures can be conveniently used together.

OPERATING EXPENSES OF 100-H. P. STEAM PLANT.

As stated before, in order to make the comparison as favorable as possible to steam, it is assumed that the power, whether steam or electric, is used in units of 100 h. p.

In mining plants the consumption of coal per horse power hour, actually developed, will vary from two or three pounds for high-duty compound condensing pumps, to six or seven pounds for ordinary engines and air compressors, and ten or fifteen pounds for small hoists and sinking pumps. For most mining plants an average of seven pounds per actual horse power would be a moderate estimate.

Estimates are made with coal at various prices from $1 to $20 per ton. In most mining districts on railroads coal will cost from $4 to $8 per ton. At many mines in high altitudes, where it has to be packed up on jacks, it will cost from $15 to $20 per ton.

The item of depreciation and repairs will be high, especially for boilers, the latter ranging from 10 per cent. to 20 per cent., according to the quality of water, and even higher in many cases. Depreciation and repairs will be higher for steam plants than for electric, and the allowance in the following estimate is probably too low rather than too high. The average cost of complete steam plant, including engines, boilers, pump, heater, piping, etc., set up in running order

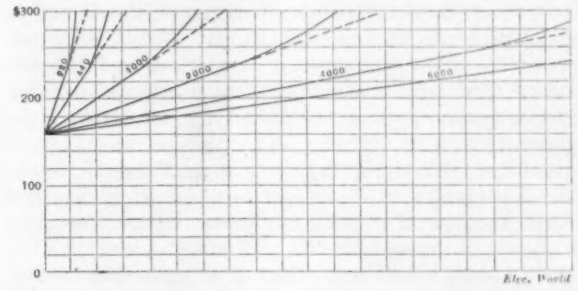


FIG. 4 (500 H. P.).—TRANSMISSION OF POWER CURVES.

Figures on the left show minimum total cost of plant per horse power on motor pulley. The horizontal scale represents distance in feet, each space representing 5,000 feet. The straight lines show minimum cost, and the curved portions show lowest practicable cost (line loss 23 per cent. of dynamo voltage).

is assumed to be $50 per horse power—a moderate estimate for most localities.

ANNUAL EXPENSE.

	10 hours per day.	24 hours per day.
Coal at $1 per ton	$1,277	$3,066
Engineer	1,800	5,400
Fireman	1,200	3,600
Oil, waste and incidentals	400	800
Depreciation and repairs ....7 per cent	350 12 per ct.	600
Interest, 20 per cent	1,000	1,000
Insurance and taxes, 1 per cent	50	50
Total	$6,077	$14,516
Per h. p.	60.77	145.16
Coal at $1.50 per ton	67.16	160 49
Coal at $2 per ton	73.55	175.82
Coal at $4 per ton	99.10	237.14
Coal at $6 per ton	124.65	298.46
Coal at $8 per ton	150.20	359.78
Coal at $10 per ton	175.75	421.10
Coal at $15 per ton	239.62	574.40
Coal at $20 per ton	303.50	727.70

From the above estimate the vertical lines in Fig. 6, representing annual operating expenses per horse power for steam power in 100-h. p. units, are plotted; the broken lines represent 10 hours per day, the full lines, 24 hours per day.

APPLICATION OF CURVES.

Assume that it is proposed to transmit 200 h. p. a distance 4,500 feet, and that, as part of the power is to be used underground, it is desirable to limit the E. M. F. at motor to 440 volts. Power is used 24 hours per day. Coal costs $6 per ton. Water-power plant costs $40 per horse power on pulley of wheel. Equation (*B*) shows that minimum cost will be obtained by allowing a drop in line of 83 volts, which is 19 per cent. of motor voltage (16 per cent. of dynamo voltage) and within the assumed limit of 30 per cent. of motor (23 per cent. of dynamo) voltage.

In Fig. 3 (for 200 h. p.) follow the ordinate 4,500 feet until it intersects curve for 440 volts, then follow the abscissa horizontally until it intersects axis of minimum cost of plant at $203; showing this to be the minimum cost per horse power. On Fig. 6 follow the corresponding horizontal line to curve of annual operating expenses 24 hours per day, hence on vertical ordinate to operating expenses; showing annual operating expenses per horse power (including

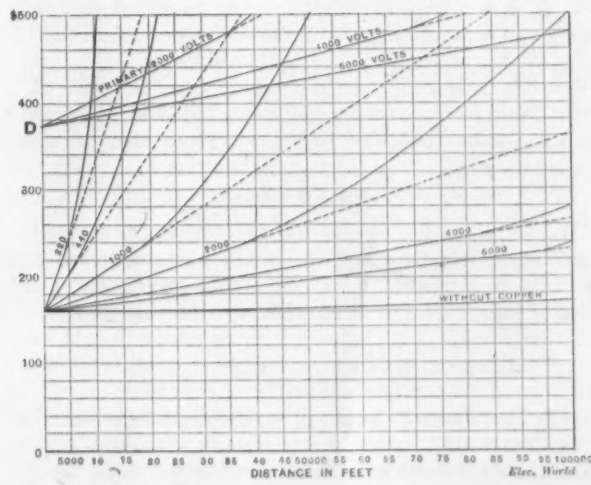


FIG. 5 (1,000 H. P.).—TRANSMISSION OF POWER CURVES.

Figures on the left show minimum total cost of plant per horse power on motor pulley. The horizontal scale represents distance in feet, each space representing 5,000 feet. The straight lines show minimum cost, and the curved portions show lowest practicable cost (line loss 23 per cent. of dynamo voltage). Curves beginning at *D* refer to double conversion plants.

*A paper read before the Colorado Scientific Society.

*The allowance for repairs and depreciation is somewhat decreased, because company makes its own repairs and wages of mechanic are included in regular expenses.

depreciation, repairs, taxes, insurance and 20 per cent. interest) to be $110. The operating expense for steam power, twenty-four hours per day, coal $6 per ton, is shown in same figure to be $298. The saving is $188, or 92 per cent. profit on $203, cost of plant, in addition to the 20 per cent. interest included in expenses.

If power is used only ten hours per day, the same process shows an annual saving of $44 per horse power, or a profit of 21 per cent. above the 20 per cent. interest.

Assuming that 1,000 h. p. is to be used 10 hours per day, coal $4 per ton, and reversing the process by starting at the intersection of expense curve for electricity (10 hours per day) with expense line for steam (10 hours per day), coal $4 per ton, and passing along the horizontal abscissa to the cost curve, 440 volts, and thence down the ordinate to the axis of distance, we find that 14,600 feet is the greatest distance at which electric power at 440 volts can compete with steam when coal is $4 per ton and yield 20 per cent. interest on the investment. With 1,000 volts the limiting distance would be 33,000 feet. If 2,000 volts can be used, and coal costs $6 per ton, the limiting distance would be 87,500 feet. If coal costs only $1.50 per ton, and granting that 6,000 volts at motor can be successfully employed, it will pay to transmit power 56,000 feet (10.6 miles) if used 10 hours per day, or 265,000 feet (50.2 miles) if it can be utilized 24 hours per day. The curves are not sufficiently extended to show the latter distance, which is obtained by calculation from equation (1*a*).

The lowest limit in Fig. 5, as previously explained, shows the limit of cheapness which can be approached but not reached, except by a decrease in the cost of manufacture of the machines themselves. The alternating and "three-phase" systems, which are regarded as a possible solution of the problem of long distance transmission, require converters at the generating station to raise the voltage to the enormous amount desired, and another set at the motors to lower it again, and although it is quite probable that the "three-phase" generators and motors can be made considerably cheaper than continuous current machines, the cost of converters will probably more than offset this difference, so that the cost of plant can hardly fall below that shown in the curve just referred to. It is not intended to disparage the possibilities of the "three-phase" system, or to deny that it may render practicable transmission to distances far beyond what may be attained by continuous currents, provided always that the price of coal is high enough to give sufficient margin to pay interest on the cost.

It is simply intended to show that even if this system fulfills the most sanguine hopes, it can hardly reduce the cost of plant below that shown in the curve described, in which copper and line loss are entirely eliminated, a condition that can never be attained by any system of which we have any conception, although the "three-phase" system may approximate more closely to it than the continuous current method. Consequently by comparing the operating expense of this ideal plant of 1,000 h. p. used in a single unit with those of a 1,000 h. p. steam plant also used in a single unit, comprising the best boilers and triple-expansion engines, and consuming per horse-power hour two or three pounds of coal costing $1.50 per ton, we can get at least an approximate idea of the distance beyond which electricity, with all the improvements that can reasonably be expected, cannot compete with steam power where coal is very cheap. From the corresponding curves of Fig. 2, applying the same process as before, we see that the expense curves for steam and electricity, used 10 hours per day, intersect at 122, or considerably lower than any point of curve of cost of plant "without copper," showing that the saving will not pay 20 per cent. on cost of water-power plant, dynamos and motors without any line, unless this is reduced below $122 per horse power delivered on motor pulley. If, however, the power is used 24 hours per day, electricity can compete with steam at a distance of about 19 miles, and pay 20 per cent. on the investment.

This has little bearing on the mining question, as coal is never cheap in metal mining districts, but it is interesting from a general standpoint, and gives some idea of what Denver may hope from the mountain streams.

DOUBLE CONVERSION.

To determine at what point double conversion would become preferable to direct transmission, an equation and curve showing minimum cost of double conversion plant should be deduced, and the intersection of this curve with the corresponding curve for direct transmission would indicate the distance within which the latter would cost least, and beyond which the double transmission plant would be least in first cost. It must be remembered, however, that the latter should be considerably cheaper to make it preferable, as the total efficiency is lower while it is more complicated, requires more men to run it, and would probably cost more for repairs. How much cheaper it should be to make it preferable is a question to be carefully studied in each particular case, as the additional complication and cost of attendance would depend greatly on circumstances.

As the secondary distance will vary as well as the primary, there could be an indefinite number of combinations requiring different solutions, so that it is impracticable to deduce any general equation on the subject. As the secondary distance would usually be rather small, it would seldom be necessary or desirable to lose more than 10 per cent. in secondary line; on the other hand, as this distance would generally be underground, requiring low voltage and best waterproof wire, a reduction of the loss very much below 10 per cent. would rapidly increase the cost of wiring while not effecting any very great gain in economy. It is fair to assume, therefore, that the loss in secondary would generally not vary much from 10 per cent. With 220 volts and an average distance of 1,000 feet underground and 10 per cent. loss, the cost of wiring (including labor) would be in the vicinity of $20 per horse power. To get a rough idea of the relative advantages of direct transmission and double conversion, we will make the following assumptions, which will represent average conditions:

Secondary motors, efficiency 80 per cent., cost in place $52 per horse power on pulley. Loss in secondary line 10 per cent.

Secondary generators, efficiency 85 per cent., cost in place $40 per E. H. P. at brushes.

Primary motors, larger than secondary, efficiency 85 per cent., cost in place $40 per horse power at brushes ($47 per horse power on pulley).

Primary generators, efficiency 90 per cent., cost in place $40 per E. H. P. at brushes.

Primary line, loss to be determined to give minimum total cost.

Water power, cost $40 per horse power on pulley of wheel.

Then 1 h. p. on pulley of secondary motor = 1.25 h. p. at brushes of same = 1.39 h. p. at brushes of secondary generators = 1.64 h. p. on pulley of primary motors, = 1.93 at brushes of same = $1.93 \frac{e^1 + V^1}{e^1}$ h. p. at brushes of primary generator = $2.14 \frac{e^1 + V^1}{e^1}$ h. p. on pulley of wheel.

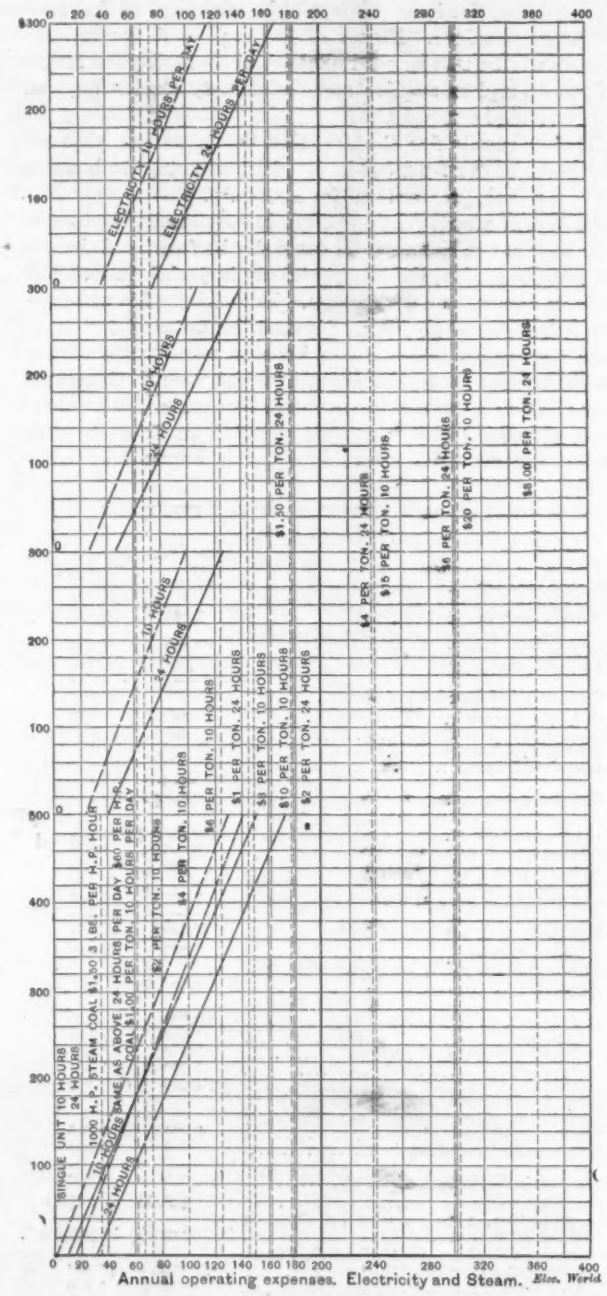

ELECTRICITY 10 HOURS PER DAY
ELECTRICITY 24 HOURS PER DAY
10 HOURS
24 HOURS
$1.50 PER TON. 24 HOURS
$4 PER TON. 24 HOURS
$15 PER TON. 10 HOURS
$6 PER TON. 24 HOURS
$20 PER TON. 10 HOURS
$8.00 PER TON. 24 HOURS
$6 PER TON. 10 HOURS
$1 PER TON. 24 HOURS
$8 PER TON. 10 HOURS
$10 PER TON. 10 HOURS
$2 PER TON. 24 HOURS
$4 PER TON. 10 HOURS
$6 PER TON. 10 HOURS
$8 PER TON. 10 HOURS
$10 PER TON. 10 HOURS
SINGLE UNIT 10 HOURS
24 HOURS
1000 H. P. STEAM COAL $1.50 3.86 LBS. PER H.P. HOUR
1000 H. P. SAME AS ABOVE 24 HOURS PER DAY 360 PER H.P.
COAL $1.00 PER TON 10 HOURS PER DAY
10 HOURS
24 HOURS
0 20 40 60 80 100 120 140 160 180 200 240 280 320 360 400
Annual operating expenses. Electricity and Steam. Elec. World

Fig. 6.—Transmission of Power Curves.

Figures on the left indicate the maximum total cost of plant per horse power delivered on motor pulley.

The total efficiency will be $.467 \frac{e^1}{e^1 + V^1}$. If the drop in primary line is 20 per cent. of voltage at dynamo, total efficiency will be 37 per cent.; with 10 per cent. primary drop it will be 42 per cent.; and however small the primary drop is made the efficiency can never exceed 46.7 per cent., provided 10 per cent. drop is allowed in secondary line, as assumed in above discussion. With no loss in secondary or primary line, total efficiency cannot exceed 52 per cent.

The curves for direct transmission are drawn under the assumed condition that line drop must never exceed 30 per cent. of motor voltage = 23 per cent. of dynamo voltage, and within the straight portions of these curves the loss is less than this; consequently the total efficiency never falls below .90 × .77 × .80 =.55, which is higher than the highest attainable efficiency with double conversion when line loss is reduced to zero, and from one-third to one-half higher than any efficiency that can actually be obtained by double conversion, allowing reasonable line losses, as dictated by minimum cost or lowest practicable cost.

The expression for total cost of a double conversion plant becomes on the above assumption,

$$C = \underset{\text{Sec. Motor.}}{52} + \underset{\text{Sec. Line.}}{20} + \underset{\text{Sec. Dyn.}}{56} + \underset{\text{Prim. Motor.}}{77} + \underset{\text{Prim. Dyn.}}{77 \frac{e^1 + V^1}{e^1}} +$$

$$\underset{\text{Power.}}{86 \frac{e^1 + V^1}{e^1}} + \underset{\text{Prim. line.}}{\frac{.055\, D^2}{e^1\, V^1}} + \underset{\text{Pole line.}}{\frac{.1\, D}{H.\,P.}} + \underset{\text{Gen'l exp.}}{\frac{300}{H.\,P.}} + 2\,(E).$$

The condition for minimum cost is the same as in the case of direct transmission, $V^1 = .0184\, D$, as the only variables are primary line, primary dynamo and power, same as before. Substituting and reducing,

$$C = 370 + \left(\frac{6}{e^1} + \frac{1}{H.\,P.}\right) D + \frac{300}{H.\,P.}$$

Curves are plotted from this equation in the diagram for 1,000 h. p. (Fig. 5) using 2,000, 4,000 and 6,000 volts in the primary circuit, and afford a comparison with the direct transmission method. For some reasons given in case of direct transmission, the drop in primary circuit should be limited to 30 per cent. of voltage at motor (23 per cent. of dynamo voltage), and beyond the distance where minimum cost demands greater drop than this, the minimum cost line is broken, and the curve for "least practicable cost," based on the above drop throughout, is drawn full.

The equation from which this curve is plotted is obtained by substituting $V^1 = .3\, e^1$ in equation (*E*) which becomes

$$C = 419 + \frac{.183\, D_2}{e^1\, V^2} + \frac{1\, D}{H.\,P.} + \frac{300}{H.\,P.} \qquad (2a).$$

These curves show that a double conversion plant using 6,000 volts in primary costs less than a direct transmission plant using 220 volts beyond 8,700 feet, and costs less than a 440-volt direct plant beyond 17,600 feet. With 2,000 volts in primary, these distances are 9,100 feet and 19,200 feet respectively. It does not follow, however, that double conversion should be used beyond these distances.

The total efficiency of the double conversion plant (6,000 volts) at 17,600 feet is 44 per cent. and the efficiency of direct plant (440 volts) at same distance is (23 per cent. loss in line) 55.4 per cent., while the efficiency of the double transmission plant (2,000 volts) and the direct plant (440 volts) at 19,200 feet, where they cost the same, are 39.6 per cent. and 55.4 per cent. respectively. If there is more water power all the year round than can be utilized (a rare case), the low efficiency of the double conversion method would have little weight, but in most cases there is use for more power than can be obtained throughout the year.

On account of its inferior efficiency, greater numbers of machines, greater depreciation and repairs and greater cost of attendance, it is plain that double conversion should not be used until a distance is reached where it is very much cheaper than direct transmission, exactly how much depends altogether on circumstances; as 440 volts can be used almost universally in mining (except in such special cases as percussion drills requiring a peculiar pulsating current, or house lighting where connection of lamps in series would be inconvenient), it is safe to say that double conversion should seldom be used below five miles.

This discussion is, of course, not intended as an accurate guide in considering problems in transmission of power. It simply presents graphically and correctly enough for ordinary purposes the general conditions and limitations of electric transmission of power under average conditions in mining districts, and enables one to determine at a glance whether a proposed enterprise has sufficient merit and promises sufficient profit to make it worthy of careful consideration.

If the plant is to be actually installed the engineer will apply the actual conditions in all their details, and make accurate estimates in accordance with the various plans that may suggest themselves, and thus determine the best and most economical plant for that particular case.

The general conclusion to be drawn from the equations and curves presented is that as in a great part of the mining districts of the State coal costs over $4 per ton, and water power is available within one to five miles, the installation of electric power transmission plants presents a very attractive investment for capital, provided it is practicable to successfully apply this power to the various operations of mining.

Electric Lighting in Athens.

Information concerning the works and progress of central stations is always of interest, but that which comes from such a source as the ancient city of Athens, Greece, is particularly so. The station there has been in operation three years, and considering that Athens is a city of only 100,000 inhabitants the progress made is very encouraging. At the close of 1891 there were installed 94 arc lights (excluding the street lights) and 5,631 incandescent 16 c. p. lamps, an increase of 12 arc and 1,793 incandescent lights during the past year. For the year 1890 the total output, as measured at the station, was 2,066,870 ampère hours, while that indicated by the meters of the consumers was 1,901,355. This makes the total loss by leakage, faults in the meters and inaccuracies in weighing the plates (Edison meters are used) as only about 8 per cent. The gross income for this amount of current was 198,120 francs, or $39,624 (calling the franc for convenience as exactly 20 cents), which left a total earning of 78,360 francs or $15,672.

The station is now running under full load. During the present year a new boiler will be erected and a 150 h. p. engine, driving two dynamos, will be added.

Current Controllers for Use in Medical Work.

BY T. J. WATERS.

As opposed to the current selector, the current controller forms in itself a separate and distinct line of apparatus. The selector is the older instrument, and may be stated primarily to be the "combined terminal" of one or many elements. The controller, on the other hand, represents a modifying power far more simple, but which has nevertheless to do with conditions far more complex. The instrument which requires for the fulfillment of its office the simple coupling or addition of one or more cells cannot be compared in point of importance with one that requires for its manipulation a power capable of overcoming the force of every element with which it is connected. Again, when we consider its special applicability for use on the medical battery, it assumes a position which, when compared with the other, places it far in the lead.

The avoidance of all complicated wiring incidental to the cell selector; the greater certainty of preventing shocks;

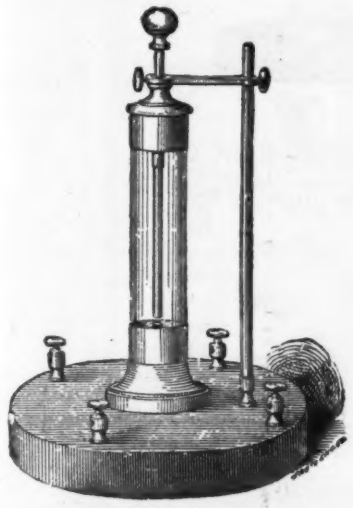


FIG. 1.—WATER RHEOSTAT.

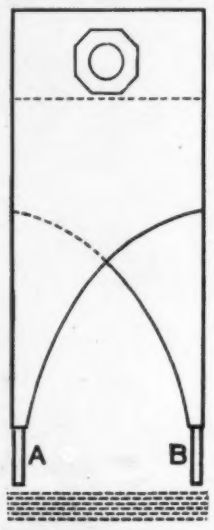


FIG. 4.—SIDE APPEARANCE OF PLATES.

FIG. 6.—MASSEY CONTROLLER.

the distribution of wear among all the cells of the battery; the freedom from danger of any particular cell being short circuited, and the need, as a rule, of but two terminal wires, are all points in its favor which make its adoption far more to be desired than that of the selector. Heretofore this very adoption has been hampered by the non-existence of forms which would reach even half way toward perfection; but of late years the manufacture of the branch of the business has taken a turn which if it has not reached the point aimed at has at least advanced a long way toward it. The controller as viewed to-day may be divided roughly into two classes: one which depends on a liquid as the mode of resistance, and of which the old water rheostat is the type, and the other whose means of opposing the current is a solid, and which is represented by the numberless carbon and graphite rheostats for sale by the various dealers.

In point of existence for medical purposes, the water rheostat (Fig. 1) claims the preference of first mention. The idea of the use of water as a resistance material is of course an old one, and has been used as a means of modification for medical work more than any other. But the apparent simplicity which has recommended it for use has caused it to be ultimately abandoned as impracticable. The decomposition which occurs around the poles resulting in the corrosion of the metallic connections, whose final crumbling breaks the circuit; the uncertainty of water whose chemical changes in action render it unsteady as a resisting medium and the utter impossibility of securing anything like exactness have long militated against its adoption as a means of resistance.

In but one notable instance have the difficulties set forth been so overcome as to give the instrument a positive commercial value. This exception occurs in the latest form of what is known as the "*New* Bailey" current controller made by the Law Telephone Company. The accompanying cut (Fig. 2) of this instrument gives a good idea of its construction. Briefly described, it consists of two triangular carbon plates, and so mounted over a small glass of water that by means of a worm gear operated by a hand wheel the sponge tips are gradually moved down into the water and toward each other until the plates touch at their lower points. Or by turning a thumb screw, the left-hand plate may be unlocked from the gear, and moved as far into the water as desired, and then the other plate gradually turned down toward it. The last method gives a still more gradual increase of current. Each shaft passes through the centre of a hole running the entire length of the longest edge of the plate, and molded in with pure tin, the tin completely filling the space between the shaft and the carbon from end to end. An electrical connection is thus had having an abundance of conductivity, and which is at the same time not subject to corrosion. The whole apparatus weighs two pounds. The carbons are well molded and the mountings are nicely finished and well fitted.

As a development of the water rheostat this instrument marks a distinct advance, inasmuch as the objections stated above have in a great measure been overcome. In the "Old Bailey" instrument (Fig. 3) the operator had to contend with all the various annoyances of the ordinary rheostat. Its action was very little different from the latter, and hence it was open to all its shortcomings. It consisted of four carbon plates which were mounted so as to be readily immersed in a jar of water by means of a rack and pinion. The plates were connected together in pairs insulated from each, and each pair connected finally to a terminal attached to the lid. Hence it will be seen that its action was very like the old form except in the one particular that the former based its action on the amount of carbon immersed, while the latter depended more on the distance between the poles. In the new form, however, the objections so apparent in the old are obviated. The presence of the tin makes corrosion impossible. The formation of water by capillary attraction on the insulating strips between the carbons of the old is not possible on the new because of the difference in formation. The gradations of current strength are rendered more regular in the new, a thing not possible in the old. And finally, the enormous decrease in bulk makes the use of the new kind possible in cabinets where the lack of space was a positive bar to the use of the old.

Those operators possessing the *old* style and having cabinets fitted up especially for them may remedy most of the defects mentioned by taking the instrument apart and altering it in the following manner. Unscrew the carbon plates from the suspending rod and rack, and, after subjecting them to a dry heat equal to the temperature of melted paraffine immerse the upper end of the carbon plates, connections and all into melted paraffine or other insulating material, down to a point indicated by the line *Z* in Fig. 3. Before doing this, however, take the plates apart, and cut the lower ends in the manner indicated by *X* in Fig. 3 so that the corners formed by the opposite pairs of plates will form a paraboloid. Bore a fine hole in the lower end of each carbon plate, and insert therein a piece of graphite from a lead pencil, one-half inch in length. The plates when viewed from the side now present the appearance shown in Fig. 4. When treated in this manner the condition of affairs is much changed. The connections will not corrode and the immersion being more gradual, the corresponding gradation of the current is more even.

In manufacturing for the medical profession the electrician must take strict cognizance of the fact that he has oft-times to deal with forces quite outside the domain of electrics; otherwise he is apt to meet with hindrances which might not be considered as such. The writer examined a small medical rheostat, recently, which had been imported from Paris. The name of "Leiter" ought to have been a sufficient guarantee of its excellence, and, indeed, from the electric standpoint, it was quite enough so. But to the mind of its owner, a physician of high repute, it possessed a serious defect—this to the effect that the continuity of its action was not sufficiently regular to allow of use in modifying a current applied to delicate portions of the body. It was a button rheostat, sliding contact, and when placed in circuit with a sensitive galvanometer, and the resistance diminished by moving the selecting arm, no movement or oscillation of the needle other than the natural increase in the reading was perceptible. When, however, suitable electrodes were introduced into the circuit and placed on the temples just behind the eyes, a distinctly perceptible flash was observed to take place at every additional contact. This might argue a break in the circuit, as the amount of resistance thrown out at each button was too small to suppose the flash was caused by the increase. And as the reliability of the meter used is unquestioned, it might seem like straining the point too far; yet it is a point which will be sustained by every neurologist of repute, and one which may be considered well taken when we consider the delicacy of some of the internal organisms on which it is necessary to operate. The difficulty encountered in overcoming the objection has almost caused the total disuse of button rheostats, and where coils have been used as the resisting medium it has done so entirely.

FIG. 5.—WILLMS' CURRENT CONTROLLER.

There has lately been put on the market a new instrument which would seem to obviate what has heretofore been objectionable. In Fig. 5 we have an arrangement which might at first sight appear to be a modification of that of Gaiffé, but which, on closer inspection, exhibits points of superiority not discernible in the French instrument. This is the Willms unalterable current controller, made by the Chloride of Silver Battery Company, of Maryland. The particular point worthy of commendation is the close proximity of the points of contact. The resisting material, consisting of common glue, graphite and metal filings (brass preferred) is placed on the under surface of the top plate, the graphite being really the resisting material, the brass filings collecting the current and conducting it to the metal contact points leading to the surface, where the turning crank formed a connection with them. The little brass pins or contact points do not penetrate the graphite. The hard rubber disc is surfaced as smooth on the under as it is on the upper side, the length of the pins having nothing to do with the increase or decrease of the resistance. The latter in this case depends on two things: the proportions of the material used in the compound and the shape of the material forming the resistance. The latter is affixed in the following manner: The shape of the resistance is first painted on the hard rubber plate, which is then put into a gently warmed press, and under a powerful pressure the resisting material is made to adhere to the glue. The plate remains in the press for at least thirty minutes, and when perfectly cool is removed. The warming process is apt to warp the plate, making good contact impossible; therefore, the top of the plate is again surfaced, making it perfectly even, after which the switch is attached. The maximum resistance of the controller is 35,000 ohms, the minimum less than four. The perfect smoothness with which this instrument works is attested by the fact that no flashes occur when the current is increased and the electrodes in position behind the eyes.

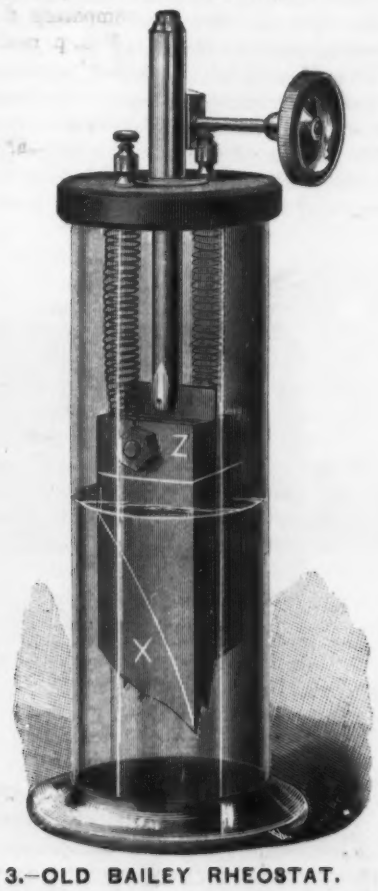


FIG. 3.—OLD BAILEY RHEOSTAT.

In Fig. 6 we have what is known as the Massey current controller. It consists of a porcelain plate provided with a nickel-shaped conducting area of graphite broadening and thickening up to a terminal, when the graphite unites with a metallic surface which is in direct contact with the battery. A sliding arm determines the amount of surface and consequently the amount of resistance in circuit. It is the elucidation of a principle correct enough in itself, but whose practical manipulation depends upon conditions. For currents of sufficient intensity and low ampérage nothing could be better, the utter simplicity of the action adding to its desirability. The extreme thinness of the resisting medium, however, would render it unsuitable to

a reverse condition, but as this would rarely or never be the case in medical work, the objection which we have heard made could remain uncalled for.

The mechanical construction of this instrument is most excellent and unites well with its intrinsic qualities in adapting it to the purpose intended in its use. A difficulty was the obtaining of a good enough electrical contact between the metallic portion beneath the part marked 2 and the graphite. This was finally obtained by electroplating a sufficient quantity of metal directly onto the graphite. By this means the contact is rendered absolute, and entire resistance may be thrown out if it is so desired by moving the sliding arm completely, around when what is practically hard metal may be reached. In using the incandescent current for galvanic work the intervention of one lamp at 110 volts and this rheostat will reduce the consequent half ampère to the finest gradation.

Various modifications have appeared, notably that shown in Fig. 7, when the sliding contact portion of the movable arm gives place to a wheel or roller. The sickle-shaped arrangement of the graphite is replaced by a ribbon-like formation of the same substance which reposes on a raised circular platform over which the "wheel" passes.

A still further modification of the last is the little instrument shown in Fig. 8 and which is made by the Waite & Bartlett Company. The cut is not much less than natural size and for convenience of carrying and manipulation it is the more to be desired of the two. The wheel reverts back to the sliding arm again and, if anything, it is the better form because of the greater amount of friction, and, consequently, better contact obtained. One advantage the wheel obtains over the frictional bar is the greater immunity from dust, which coming between the arm and the graphite is liable to break contact and result in dangerous shock.

Fig. 8.—Bartlett & White Current Controller.

The most unique idea which has of late years evolved itself into the form of a rheostat is one whose greatest charm lies in the simplicity of its construction. Complications in electrical work are always to be avoided and the instrument which combines simplicity with efficiency is always the most to be desired. Carbon as a resistant for medical work has for the most part been subordinated to graphite and consequently the real carbon rheostat, strictly so called, is in this branch of the business at least somewhat rare. Those that have existed have assumed forms not at all economic, and they have furthermore nearly all been based on a principle that required the introduction into the circuit of a greater or lesser length of the hard material. While granulated carbon has been used for the purpose before, it has never been introduced in a shape that admitted of such curtailment of bulk as we have it in the rheostat shown in Fig. 9.

Fig. 9.—Vetter Current Controller.

The Vetter carbon rheostat, made by J. C. Vetter & Co., of New York, adopts the principle of the variable resistance which takes place in carbon with a change of pressure. A quantity of carbon in a finely divided state is placed in a small rubber pouch or cylinder, which is enclosed by two metal plates forming opposing ends of a circuit. The lower plate is fixed to the base of the instrument, and the other, traveling in upright guides, can be depressed, by means of a screw with a fine thread, so as to compress the carbon in the rubber cylinder. Apparently, so simple as is its construction, this instrument admits of a good deal of discussion. The broad claim is the confining of carbon powder in the rubber pouch. The function of the latter is to hold the contained powder in the position necessary to keep up the contact between the poles, and to aid, by its pliability, the manipulation of the powder as the will of the operator causes the resistance to be diminished or increased.

Fig. 10, which shows the instrument apart, gives the best idea of its mode of construction. *A* and *B* are the turning button and its attachment screw. *C C* are adjustment screws used at various heights as the amount of voltage to be used is determined upon. *D* is that part of one pole which forms the upper cap for the rubber cylinder. *E* is one of the standards which supports *D*, and the cross-bar above it. *F* is the pouch itself filled with carbon powder. *G* is the other or lower pole as opposed to *D* and *E*. In its ordinary position, that is, when the rubber cylinder stands perpendicular, the contained carbon is held by the rubber tight up against the poles, and in this elongated position offers the greatest amount of resistance to the current. As the thumb-screw is turned it forces the upper pole down against the carbon, which in its turn, for lack of space, bulges the rubber out at the sides, thus diminishing the distance and the amount of carbon between the poles and lessening the resistance until if necessary "hard contact" is made, the reverse order of things takes place on releasing the screw, the flexible quality of the rubber causing it to gradually resume its former shape, and by forcing the carbon back keep in good contact with the poles.

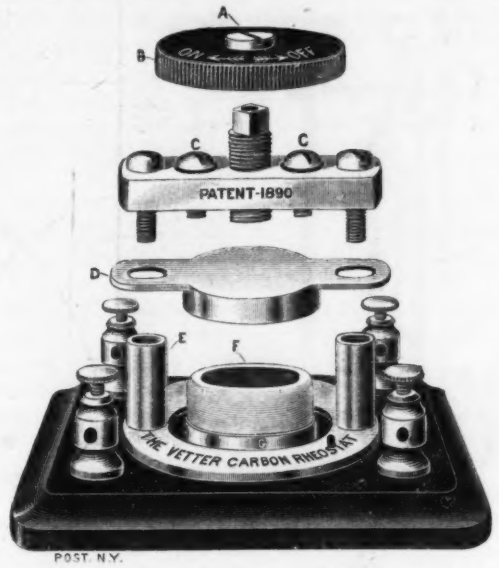


Fig. 10.—Vetter Current Controller.

Electric Lighting in Philadelphia.

Chief Electrician Walker generally has something to say in his reports, of one of which an abstract is here given, containing some facts and figures about the electrical features of that city.

The underground conduits for electric lighting, for telephone and telegraphic communications are being extended on the main streets, and the entire feasibility of that system is daily demonstrated.

He calls attention to three systems, illustrating three ways of securing electric lighting. One is the Chicago method, another that used in Paris, and the third the one here in Philadelphia.

Paris is one of the best lighted cities in the world. The city is supplied by private lighting companies, who secure the privilege of putting their wires underground on certain conditions, one of these conditions being that the municipality shall be supplied with electric light at a cost agreed upon by a commission fairly chosen, which commission allows the private corporations a fair commercial profit upon the light furnished.

The Philadelphia plan is to furnish light from companies who are practically granted by the city a monopoly, and who may charge 50 cents or a dollar per night per lamp as they choose, there being no reservation of any point in the city to regulate the price.

The several electric companies in Philadelphia enjoy privileges which are not all alike. Most of them are "overhead" companies, though some of them are confined to underground conduits entirely. Some are required to give to the city a certain number of arc lights free; others to wire and light school, police and fire houses in their territory. Two are required to pay five per cent. of their net earnings to the city, and several enjoy the privilege of putting down conduits on condition that they give two ducts to the city free of cost. Some give no return whatever to the city for their privileges.

In his judgment the whole subject should be settled by a general ordinance to provide for the furnishing of light by the companies licensed by the city at a fair price, to be fixed by an impartial commission.

This should only be a temporary solution of the problem, however. The city ought to own and control its own lighting plant. The Councils should make as liberal appropriations as possible for the extension of the underground system, the erection of poles and mast arms, and, eventually, it will only be necessary to provide the central stations.

The removal of the overhead wires is the subject which most agitates the public to-day. They mar the beauty of the streets, they form obstructions to the fire department, and more than all, they are dangerous. The only argument in their favor is economy, and this is only a matter of first cost, for the underground system is much less expensive to maintain.

The report shows that there are 1,871 arc lights, including 50 owned by the Girard Trust. There are 12,982 poles in the city, of which 7,452 belong to private corporations and 5,530 belong to the city. There are 3,556 miles of telegraph and telephone wires, and 652 miles of electric light wires in the city. In addition to that the city has 837 miles of overhead wires, making a total of 5,046 miles of overhead wires in the city.

There are 1,747 miles of underground wires, of which the city owns 136 miles. There are also 14,394 attachments by private corporations to city poles, for which the city receives 50 cents each per year, or a total of $7,197.

The progress made in laying underground wires is most satisfactory, and, considering the comparatively small outlay, shows excellent results. During 1891 there were laid by the city 3,991 feet of six-inch conduits and 4,633 feet of four-inch conduits.

The various companies by their returns show that together with that laid by the city there are 645,464 feet of

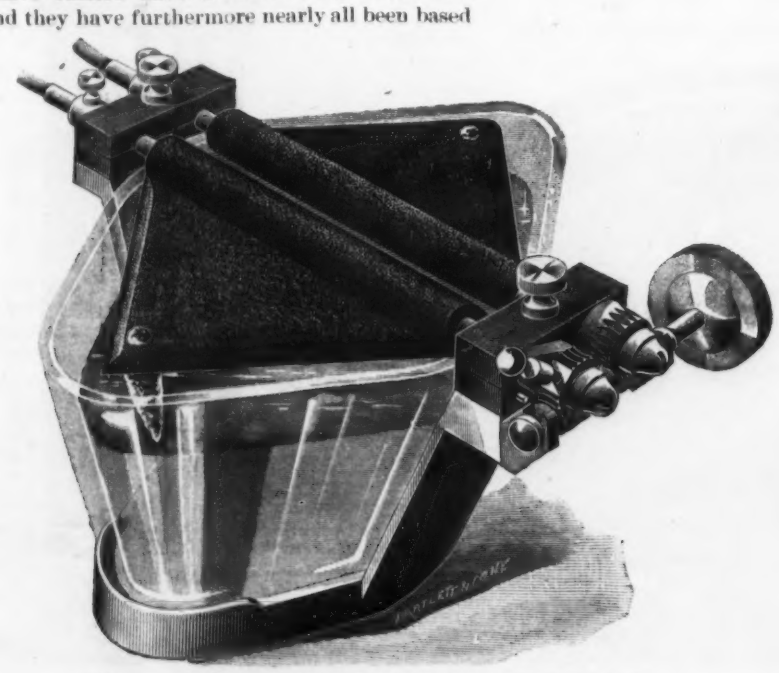


FIG. 2.—NEW BAILEY CURRENT CONTROLLER.

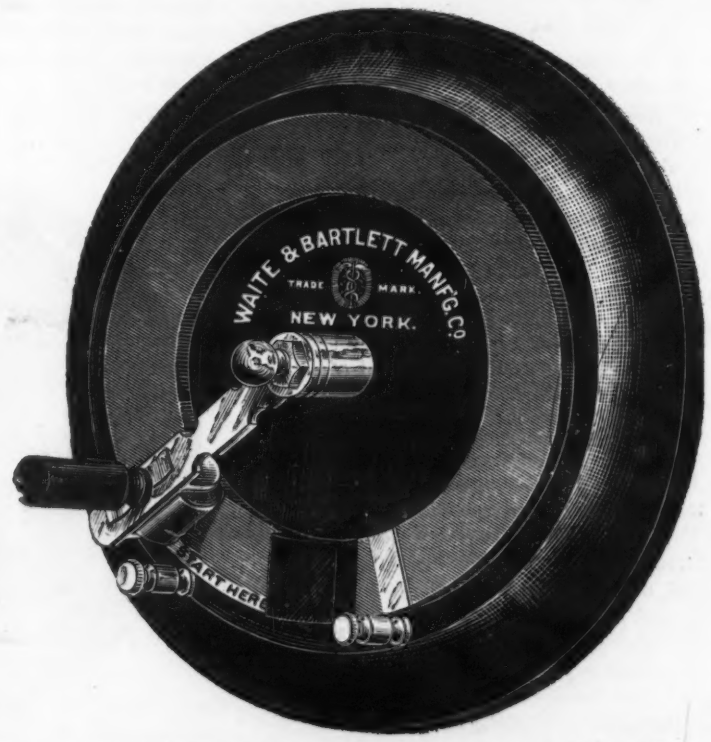


FIG. 7.—CURRENT CONTROLLER USING ROLLER CONTACT.

underground conduit (an increase over last year of 25,601 feet), of which the city owns 59,030 feet (an increase over 1890 of 11,073 feet).

The number of feet of duct laid underground by the following companies are:

American Telegraph and Telephone Company	1,925,812
Bell Telephone Company	1,127,047
Frankford Avenue Merchants' Electric Light Company	68,850
Merchants' Electric Light Company	38,160
Making a total of	3,159,869

The number of miles of wire in use by telegraph, telephone and electric light companies, together with the city wires, overhead, is 5,046.48, a decrease of 511.03 miles.

The number of attachments to city poles are 14,394, an increase of 498. The number of miles of wire placed underground during the year 1891 was 1,474.39. The number of poles used by telegraph, telephone and electric light companies (exclusive of those along railroads) on the highways of the city is 7,452, an increase of 825. The number of city poles is 5,580, an increase of 221, making a total of 12,982, or an increase of 1,050 over that of 1890. The number of messages transmitted over the police wires was 324,202, an increase of 21,582 over 1890.

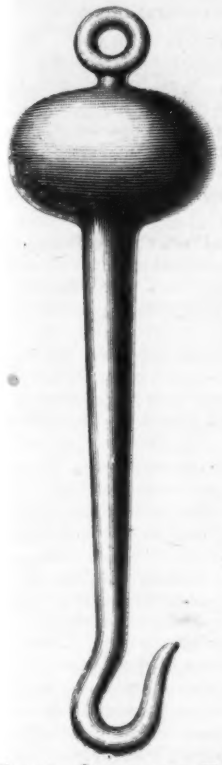
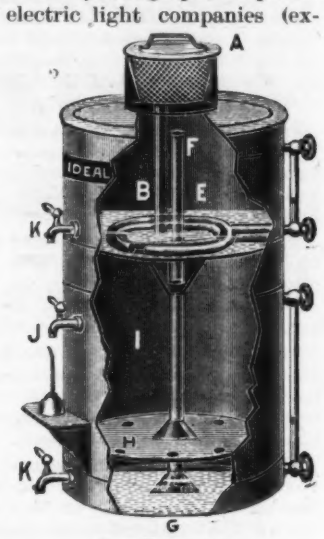


FIG. 4.—INSULATED HOOK.

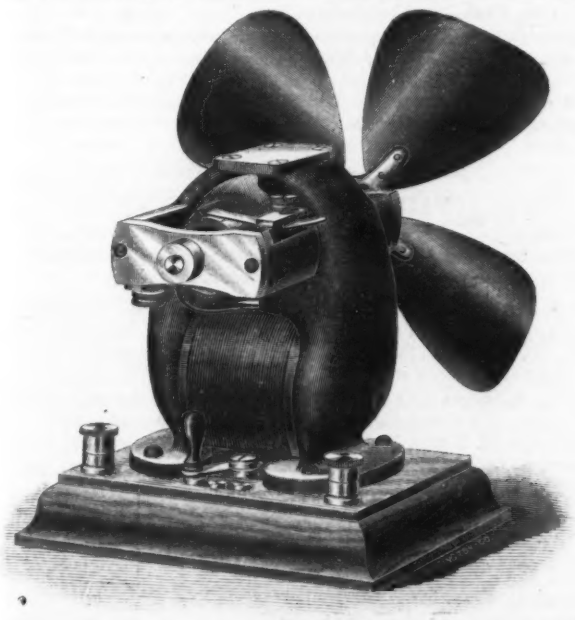


OIL PURIFIER.

The Bernstein Electric Fan.

No portion of the electrical business has had a greater growth during the past few years than that pertaining to the use of small motors for ventilating fan work and the driving of light machinery. Thousands of such motors are in use to-day, and their number, as well as their scope of utility, is continually increasing. The cut shown represents a small motor for continuous currents recently put on the market by the Bernstein Electric Company.

While there are no distinct peculiarities in its construction, care has been taken in the manufacture and finish to make it thoroughly efficient and tasteful. Realizing that such motors are generally in the hands of those who know little about electrical matters, particular attention has been given to the design and winding of the armature, so that it is practically non-sparking, it is claimed, irrespective of the position of the brushes within a considerable range.



BERNSTEIN FAN AND MOTOR.

The smallest type is intended entirely for fan work, the speed being either 2,000 or 17,000, with a heavy 8-inch fan. The larger sizes are either used for heavier ventilating fans or, as they are wound for constant speed, are suitable for light power work.

The "Ideal" Oil Refiner.

The simplicity of construction and automatic action, the fact that it can be cleaned without drawing off the oil, and that it is operated by steam and water are advantages which the oil refiner claims over the oil filter. The "Ideal" oil refiner, a recent invention, is herewith illustrated. The chambers *E* and *I* are filled with water to a depth of six inches and steam connections made as shown. The dirty oil is poured into the receiver *A*, where it strains into the pipe *B*, flowing down to the bottom of chamber *E* through the water. Steam is then turned on, and the refining process begins. As more dirty oil is added there is an overflow into the pipe *F* down through the water to the bottom of reservoir *L* and up and around disc *H*. When the oil gets above the cock *J* it can be drawn off refined and pure. The two cocks *K* are for drawing off sediment and water. Whatever the gravity of the oil, the heat of the steam coil thins it and separates the grease and other deleterious matter, which settles to the bottom of chamber *E*. This refiner, it is claimed, has been found to work very successfully. It is manufactured by the Purity Oil Filter Manufacturing Company, of Pittsburgh.

FIG. 3.—TROLLEY HANGER.

Improved Electric Railroad Fittings.

A new type of fittings has just been brought out by the Mica Asbestite Insulating Company, of 444 Pearl street, New York, which is handled by the company's agent, Mr. C. H. W. Copeland, 126 Liberty street, New York city.

Fig. 1 is a section through the middle of a trolley hanger showing clearly the arrangement of its parts. In its manufacture a shell of malleable iron and a centrepiece of the shape shown are held in their respective positions and put into a press, which feeds in the insulating material and compresses it in place, under a pressure of 30,000 to 40,000 pounds. The bells are then heated, a special insulating preparation is applied to the under side to protect the bell from moisture, and they are painted with insulating paint. The result of this process, it is claimed, is a bell giving an insulation resistance of over 20,000,000 ohms, extremely strong, and practically indestructible.

The clamps are made of malleable iron in two pieces, as shown in Fig. 2. To insert the trolley wire, the keys, which are specially made and will not come out of themselves, must be withdrawn and the loose part of the clamp taken off. The wire is then laid in the recess made for it, and then the other part of the clamp is replaced with the nails. The clamps do not surround the wire but leave the lower part exposed so that the trolley in passing under them does not break contact, and does not arc. The advantages of these clamps are, that they do away with soldering and its injurious effects on the trolley wire caused by the careless use of torches, etc., and save a large amount of time during construction.

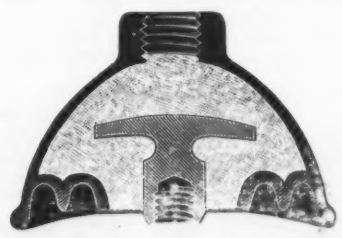


FIG. 1.—SECTION OF TROLLEY HANGER.

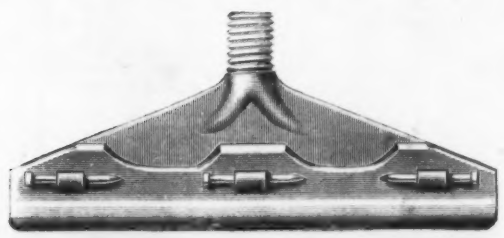


FIG. 2.—TROLLEY CLAMP.

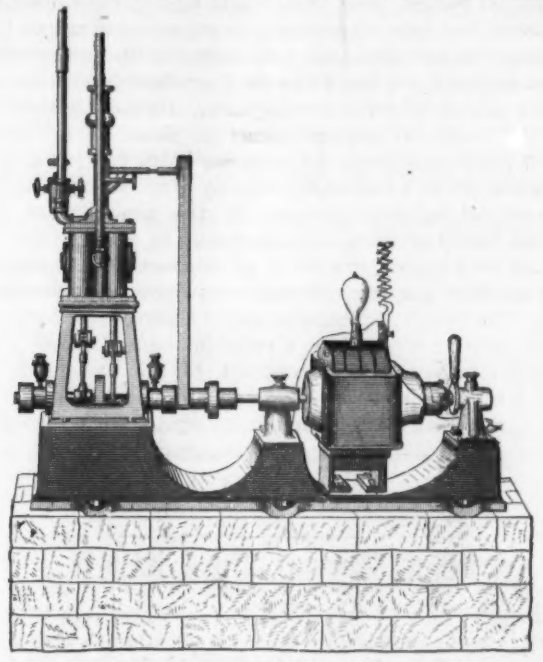
Fig. 3 shows an arrangement of bell and clamp used in places where guard wires are demanded. Clamps are made long or short to suit the various conditions, and also with eyes so that they may be used to strain up the trolley wire. The clamps may be screwed direct into the bell or connected to it by a clevis.

The part necessary to engage the span wire is also made separately, without eyes for guard wires, so that it may be applied to a plain bell, by screwing it into the top of the bell.

Fig. 4 shows an insulated hook, which has a variety of uses. It is made and insulated in a similar manner to the bell.

A Directly Coupled High-Speed Engine.

A two-horse power, high speed, directly coupled engine is here shown. The arrangement is very compact, only occuping a space three feet two inches by 10 inches. The engine, which is recommended to run at about 800 revolutions, has two double-acting cylinders, with cranks at 90 degrees. The frame is of the A pattern, and the cylinders are formed in one casting. The semi-cylindrical valves have an action like the regular slide valve, receiving their motion from the piston. The piston and valve of the right hand cylinder control the admission and cut-off of steam in the left hand cylinder, and vice versa.

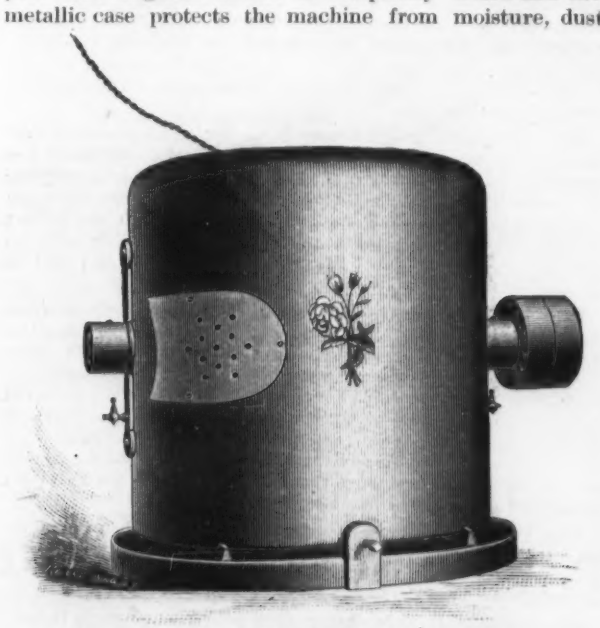


DIRECT CONNECTED ENGINE AND DYNAMO.

The dynamo here shown has a capacity of 16 incandescent lights, 16 c. p. The total weight is 350 pounds. The outfit is especially designed for steam yachts, offices, etc. The manufacturers are the Short Duplex High Speed Engine Company, 112 Liberty street, New York.

A New Ironclad Motor.

The accompanying illustration shows an ironclad motor just brought out by the Erie Machinery Supply Company, of Erie, Pa. The best of material and workmanship have been embodied in the machine. The bearings are large, self-oiling and self-aligning. An adjustable iron base provides for the tightening of the belt. The brushes are composite, permitting the rotation of the armature in either direction, and the commutator bars are of tempered copper. The magnetic circuit is completely closed and the metallic case protects the machine from moisture, dust and all mechanical injuries. It is claimed that the motor runs without noise or sparking, is automatically regulated and has a high efficiency.



IRON CLAD MOTOR.

Edison Triple Expansion Engine and Multipolar Generator.

In our issue of March 26, 1892, we illustrated and described the Edison multipolar generators geared directly to the shaft of a triple expansion engine, but were not then in possession of exact particulars regarding the engine. The engine is of the triple compound three-crank, inverted cylinder, automatic condensing type, well proportioned throughout, having large wearing surfaces which can be easily adjusted. The bedplate to which the main bearing boxes of the crank shaft are cast is strong, and is firmly

bolted to a massive foundation box, which also carries the dynamo frames, insuring perfect rigidity between engine and generators. The crank shaft is of forged steel, fitted with cast iron balanced discs, to which the crank pins are fitted. There are two bearings to each crank and an additional large bearing on each end of the shaft to carry the armature. On the shaft are three eccentrics, each operated by its own independent governor so that the point of cut-off in each cylinder is changed equally with the load, thus doing away with any tendency to race in case the total load is at any time thrown off or any accident happen. Strong cast iron columns carry the cylinders, which are bolted together, and the engine made strong, compact and well arranged; indeed, these engines are almost fac-similes of the latest and most improved types at present in use on the finest ocean steamships, with necessary additions to render them as highly efficient for electric generating purposes as their prototypes are for marine work. They are calculated for the maximum efficiency point at about 12½ per cent. below the normal maximum capacity of the generator, and have a range to a maximum capacity of 20 per cent. above the normal maximum output of the generator, at 160 pounds initial pressure and vacuum of 24 inches, thus allowing each engine, in case of an accident to the condensing apparatus, to operate satisfactorily non-condensing. In addition to the advantages already mentioned these engines when connected to a suitable condenser will, it is claimed, reduce the consumption of fuel considerably, which is an item of vast importance in electric light stations, increasing their storage, boiler and engine capacity.

Financial Intelligence.

THE ELECTRICAL STOCK MARKET.

New York, April 18, 1892.

Review of the Market.—There are new evidences of strength in the market almost every day, and there is little doubt but that the bull elements are tightening their grasp to effect a better condition of affairs. Prices are generally fractionally higher. The Easter season brings holidays in the stock exchanges, and the bulk of business is therefore smaller than usual; but all the brokers are confident that the incipient signs of a more active and higher market will not fail to result in the upward movement that all have been looking for during the past two months. There has been very little change in the money market. The small demand for funds has somewhat stimulated those who have available money to use in speculation in the absence of good borrowers. This gives a good amount of activity to the bond market, and these securities are readily disposed of as offered. This movement extends also to the electric bonds, which have recently found a more receptive market than ever before. The foremost bankers are offering them with strong recommendations, and they are rapidly usurping the place so long held by railroad, municipal and water bonds. Rates are unchanged at 3 to 4 per cent. for call loans and 4 to 6 per cent. for business paper.

Electric Stocks.—The prices on the electric stocks as compared with the past show either gains or certainly strength. The successful outcome of the incorporation of the General Electric Company in the New York Legislature has had a good effect on both the Edison and Thomson-Houston stocks. The former is at par and over again, and is very strong, though only moderately active. Thomson-Houston common and preferred show a material advance and increasing strength, which will probably carry the common above 60 again at an early date. Western Union has steadily advanced to still higher figures, and if predictions are well founded it has not yet reached the top. Bell telephone stock and rights both advanced at the same time, which is very unusual. Those who sold rights for the profit did not show the wisdom that usually advises such action. Westinghouse common and preferred remain very strong, evidently on their merits in the absence of any reports concerning internal matters.

The General Electric Company.—Boston advices state that now that the incorporation of the General Electric Company has been settled by the signing of the bill by Governor Flower granting its charter, the company will shortly issue $4,000,000 30-year five per cent. gold bonds to retire the floating debts of both the Edison and Thomson-Houston companies. The bonds will be offered to the stockholders of the General Electric Company at 95 and will be convertible into General Electric stock at 120.

Thomson European Electric Welding Company.—Answering an inquiry from a stockholder recently, "Rialto" in the Boston *Advertiser* stated the following: "The Thomson European Electric Welding Company has back of it the great bulk of the European patents on the electric welding process, which, in the opinion of experts, are worth a great deal more than the stock is selling for to-day. As soon as European finances get straightened out a little better and the revival in the foreign demand for American securities becomes more pronounced, I look to see European Electric Welding sell at very much higher prices."

The United Electric Securities Company has issued its tenth call, inviting proposals for sale to the company of its collateral trust five per cent. sinking fund bonds for the fourth series. This is the first call upon the fourth series.

American Bell Telephone New Stock.—Treasurer Driver, of the Telephone company, states that subscribers to the new issue of stock must make their subscriptions to four shares or multiples of four shares in order to secure the full benefits of the subscription. Only 625 shares will be issued June 1. Prepayments do not carry benefits, as the issue of stock is limited on the payment dates.

Erie Telegraph and Telephone Company.—It is stated that the Texas syndicate probably will be unable to exercise the option given by the Erie Telegraph and Telephone Company, to purchase for $700,000 the Southwestern territory. The time expires in about six months. The syndicate has placed, it is stated, about 200 shares of stock among influential parties in different sections of Arkansas and Texas.

Bonds.—The Gloucester, Mass., Electric Company has mortgaged its plant to the Old Colony Trust Company, of Boston, for $50,000, to secure an issue of bonds.

To Increase the Stock.—The officers of the Boston & Revere Electric Street Railroad Company and its counsel, S. G. Cogswell, have petitioned the Railroad Commissioners for leave to issue $75,000 new capital stock and $75,000 additional bonds, bringing the total capitalization up to $250,000. The company expects to have the road complete by July 1. There will then be 12½ miles of road fully equipped. The bonded debt would be $125,000, including the issue now petitioned for, if granted. The bonds will bear interest at 5 per cent, and will be secured by first mortgage.

Annual Reports.—The annual report of the Thomson Houston Electric Company was given in last week's issue of The Electrical World. A comparison with the year 1891 is given below, and may be of interest. Balance sheet Jan. 30:

		1892.		1891.
ASSETS.				
Accounts receivable	(90%)	$5,941,164	(90%)	$5,854,606
Notes receivable	(92½%)	1,514,040	(95%)	1,665,159
Real estate	(70%)	430,241	(70%)	350,000
Machinery and tools	(60%)	491,045	(70%)	4 0,000
Patterns and models		125,000		135,000
Patents		338,354		338,354
Local companies' stocks	(35%)	473,587	(40%)	346,430
Local companies' bonds	(70%)	1,858,570	(70%)	1,646,120
Manufacturing companies' stock		3,729,196		3,821,018
Construction Co.'s stock		1,210,750		1,022,500
United Securities Co.'s stock		525,420		487,425
Inventory		1,856,688		1,530,144
Consignments		32,117		14,096
Cash		1,727,276		632,055
		$20,263,448		$18,242,907
Common stock not delivered and premium on same		....		652,200
		$20,263,448		$18,905,107
LIABILITIES.				
Capital stock (common)		$6,000,000		$6,000,000
Capital stock (preferred)		4,000,000		4,000,000
Accounts payable (merchandise)		498,808		374,341
Notes payable (collateral)		1,429,486		1,537,357
Notes payable (plain)		587,005		769,675
Mortgage		1,200		1,200
Guarantee account		200,000		200,000
Surplus from previous year		6,022,534		1,685,416
Profits for year		2,760,781		3,091,884
Premium on stock sold		....		1,500,000
		$21,499,814		$19,159,873
Less dividends		1,236,366		254,766
		$20,263,448		$18,905,107

The percentages given are the per cent. of actual cost at which items are entered in the balance sheet in the case of real estate, machinery and tools and the per cent. of face or par value in other cases. The Douglas County Street Railway Company, of West Superior, Wis., which is owned largely by Eastern capital, gives a favorable report of its condition. Since early in 1890 electricity has been used entirely. This company owns 12 miles of road thoroughly equipped. The earnings in 1891 were $47,221; expenses, taxes and interest were $35,214, leaving net earnings of $12,007 for the year. The capital stock Jan. 1, 1892, was $100,000; together with $118,000 20-year 5s and $50,000 convertible 5s, and a note of $3,500, without interest, making total capital $271,500. The company paid 7 per cent. on the stock from the earnings of 1891. The charges for operating for the year, including interest, taxes, etc., were about 75 per cent. of the gross income. The earnings from Jan. 1 to March 31, 1892, showing increase over last year, are as follows:

	1892.	1891.	Increase.
Earnings	$14,537	$7,307	$7,230
Expenses	10,225	6,542	3,683
Net	$4,312	$765	$3,547
Charges	3,037	1,187	1,850
Surplus	$1,275	$422*	$1,697

* Deficit.

Dividends.—The Edison Electric Illuminating Company, of New York, has declared a quarterly dividend of one and a quarter per cent., payable May 2. The Edison Electric Illuminating Company, of Boston, has declared a quarterly dividend of two per cent., payable May 2. The Edison General Electric Company has declared a dividend of two per cent., payable May 2. The Thomson-Houston Electric Company has declared a dividend of $1 per share, payable May 14. An extra Thomson-Houston dividend of 20 cents was confidently expected this quarter, based upon the fact of the high figure at which the stock was taken into the consolidation; but this was rendered impossible by a clause in the agreement between the companies stipulating that there should be no depletion of assets while negotiations are pending. The "extra" will be paid at a later date to make up for this present loss through a legal oversight. The trustees of Thomson-Houston securities, series D, have declared a semi-annual dividend of 25 cents per share, payable April 30, 1892, to stockholders of record at close of business, April 23, 1892. Transfer books will be closed from April 25 to 30, both days inclusive.

Closing Quotations.—The following were the closing quotations of electric stocks on Saturday, April 16, 1892, in New York and Boston:

NEW YORK QUOTATIONS.

Name of Stock.	Par.	Capitalization.	Bid.	Ask'd.
American Telegraph Co.	100	14,000,000	60	63
Western Union Telegraph Co.	100	86,200,000	91	91⅛
Commercial Cable Co.	100	7,716,000	153	154½
Edison General Electric	100	15,000,000	100½	102
Edison Illuminating Co., of New York	100	4,500,000	81½	82½
" " " Brooklyn	100	750,000	76	80
" " " Chicago	100	750,000	138	142
U. S. Illuminating Co.	100	1,250,000	30	35
Edison Elec. Light Co. (of Europe) stock	100	2,000,000	2½	5
Edison Elec. Light Co. (of Europe) bonds	sh	30,000	65	75½
" Ore Milling Co	100	2,000,000	15	20
" Toy Phonograph Mfg. Co	10	1,000,000	....	½
Brush Illuminating Co., of New York	50	1,000,000	40	50
Mt. Morris Electric Light Co		500,000	20	40
East River Electric Light Co.	100	1,000,000	....	60
North American Phonograph Co.	...	6,600,000	5	8
New York Phonograph Co.	...	2,000,000	3	4
Automatic Exhibition Co.	...	2,000,000	3	6
New England Phonograph Co.	...	2,000,000	1¾	2¾

BOSTON QUOTATIONS.

	Par.	Capitalization.	Highest.	Lowest.	Bid.	Ask'd.
Thomson-Houston Elec	25	6,000,000	59¾	59¼	59½	60
Thomson Houston Elec. preferred	25	4,000,000	29	28½	28¾	29
Thomson-Houston Elec.—Series C	sh	40,000	....	....	8½	9
Thomson-Houston Elec.—Series D	sh	120,000	7½	....	7¼	7½
Thomson-Houston Int'n'al Elec.	100	600,000	....	....	200	225
Thomson-Houston Int'n'al Elec—Pfd.	100	400,000	....	....	101	103
Thomson Elec. Weld.	100	1,000,000	....	....	55	60
Thomson European Elec. Weld	100	1,500,000	10	....	10	12
Westinghouse Elec.—New Com.	..	6,000,000	28½	28	28	28¼
Westinghouse Elec.—Pfd.	..	4,000,000	45	43	42½	44
" " Trust receipts	..	10,000,000	17	....	17	17½
Fort Wayne Elec.	25	4,000,000	13	12½	12¼	12¾
Fort Wayne Elec.—Ser. A.	sh	80,000	7⅞	....	7	7¼
Detroit Elec	10	1,000,000	7¼	....	7	7¼
West End St. Ry. Co.—Com	50	7,150,000	74½	72	71½	72
West End St. Ry. Co.—Pfd	50	6,400,000	86⅝	....	86¼	86⅝
American Bell Tel	100	15,000,000*	199¾	198	198½	199¾
Erie Tel. & Tel. Co.	..	4,800,000	46¾	46	....	....
Mexican Tel. Co.	10	1,280,000	1.02½	....	1.00	1.10
New Eng. Tel. & Tel. Co.	..	10,304,600	53	52⅞	52½	....
Tropical Tel. Co.	10	400,000	....	....	45c.	50c.

* Ex rights, 14⅞.

NEW INCORPORATIONS.

The Independent Plumbing and Electrical Company, of San Antonio, Tex., capital stock $10,000, has been formed to purchase and sell electrical fixtures. The organizers are William Schuwirth, Ad. Wagner and John Zadich.

The Metropolis Water Company, of Metropolis City, Ill. capital stock $5,000, has been formed to furnish water, electric light, heat and power for that city. Geo. C. Morgan, Arthur M. Morgan and Henry A. Gardner are the incorporators.

The Marseilles Electric Street Railway Company, of Marseilles, Ill., capital stock $12,000, has been formed to construct and operate an electric street railway in Marseilles. Frank Montgomery, Richard Hughes and S. J. Gum are the promoters.

The National Electric Brake Company, of St. Louis, Mo., capital stock $50,000, has been formed to manufacture and sell electric brakes and other electrical appliances. Wm. Koedding, G. L. Van Beek and J. H. Grimm, all of St. Louis, are those interested.

The National Investment and Improvement Company, of Davenport, Ia., capital stock $2,000,000, has been organized to operate street railways and electric light and power plants. The promoters are Charles F. Hathaway, Henry G. Davis and Azel C. Buell, all of Davenport.

The Canton-Massillon Electric Railway Company, of Canton, O., capital stock $200,000, has been formed to construct and operate a railway between Canton and Massillon. The organizers are Wm. A. Lynch, A. J. Underhill, H. M. Lyman, L. A. Soichot, T. R. Catlin and J. W. Underhill.

The Connecticut Tramway Company, of New London, Conn., capital stock $2),000, has been incorporated to build electric light plants, street railroads and electric railroads in Connecticut. Dwight Townsend, of New York City, and Tracy Waller, of New London, are among those interested.

The Winona Electric Light Company, of Winona, Minn., capital stock $50,000, has been formed to construct and operate a plant for generating electricity for light, heat and power. T. T. Hayden, J. H. Jenkins and R. T. Dond, of Winona, and C. L. Bonnar, of Minneapolis, are the incorporators.

The Massillon Street Railway Company, of Massillon, O., capital stock $50,000, has been incorporated to construct and operate a street railway in Massillon, to be operated by electricity or other means. Wm. A. Lynch, J. W. McClymonds, C. A. Gates, Charles M. Russell and Warren E. Russell are the promoters.

The Fulton and Montgomery County Electric Railroad Company, of Johnstown, N. Y., capital stock $75,000, has been formed to erect and run an electric surface road of standard gauge. The incorporators are Robert Wempel, Fultonville, N. Y., M. B. Northrup, Johnstown, N. Y., and J. E. Sitterly, of Fonda, N. Y.

The Interior Wiring and Fixture Company, of New York City, capital stock $20,000, has been incorporated to wire and equip for electric lighting, etc. Phil. H. Klein, 527 West Thirty-fourth street; Chas. F. Duffy, 318 Broadway; Jas. F. Doyle, 70 East One Hundred and Fifteenth street, New York City, are the incorporators.

The Felt Electric Light and Power Company (incorporated in W. Va.), of New York City, capital stock $5,000,000, has been formed to manufacture and sell electrical accumulators secondary batteries, primary batteries, dynamos, motors, etc. Geo. H. Felt, N. B. Armory and G. L. Felt, all of New York, are the incorporators.

The Lawrenceville and Shenly Park Street Railway Company, of Pittsburgh, Pa., capital stock $100,000, has been formed to operate an electric railway in Pittsburg. S. J. Wainright, Jr., 3,615 Butler street, M. F. Leslie, 173 Forty-third street, and P. C. Byrne, of 320 Fifty-second street, Pittsburgh, Pa., are the incorporators.

The Arnold Novelty Company, of Tacoma, Wash., with a capital stock of $2,500, has been formed to manufacture, handle, buy and sell novelty goods, and all kinds of electrical appliances, including the Arnold electrical bracket. Mr. A. F. Esperson, W. S. Arnold, P. N. Boeringer, J. E. Small and E. N. Castulle, all of Tacoma, Wash., are the organizers.

The Columbian Electric Traction Company, of East St Louis, Ill., capital stock $1,000,000, has been formed to acquire patents, to use, sell and deal in electrical appliances, underground and otherwise and to build, construct and manufacture electric railways, plants, etc. D. J. Murnane, Geo. L. Van Beck and Stephen Von Phul are the organizers.

AFFAIRS OF THE COMPANIES.

The International Bell Telephone Company, Limited, will hold its annual meeting on Wednesday, May 4.

The Mexican Northern Telegraph and Telephone Company will hold a special meeting in New York on Monday, April 25, at 11 A. M., to consider and act upon a sale of its property to and consolidation with the Mexican Telephone Company.

The Kenton Gas and Electric Light Company, of Kenton, Ore., at a recent meeting electedthe following directors: J. N. McCoy, J. M. White, J. A. Rogers, T. Espy, J. Timmons, M. C. McVitty, A. Letson, L. Merriman, H. Price, H. C. Koller and G. W. Rutledge.

The Royal Electric Company, of Montreal, Canada, at its recent annual meeting elected directors as follows: Messrs. Thibaudeau, J. A. Strathy, F. L. Beique, A. R. Macdonald, E. A. Small, John Ross Robertson, W. J. Withal, J. T. Ross, Quebec, and Sir Joseph Hickson.

The Edison Light and Power Company, of La Crosse, Wis., at its annual meeting elected the following officers and directors: President, F. A. Copeland; vice-president, Abner Gile; secretary and treasurer, E. E. Bentley. Directors were elected as follows: F. A. Copeland, Abner Gile, G. Van Steenwyk, James McCord, E. G. Perkins, W. E. Sawyer, E. E. Bentley.

Nashville, Tenn.—The Thomson-Houston Electric Company at the recent resale of the properties of the Capital Electric Company, under decree of the United States Circuit Court, was the highest bidder, and is also the owner of the recently organized Cumberland Electric Light and Power Company in this place. Improvements are contemplated in both plants.

The Montrose Electric Light Company, of Montrose, Colo., has sold all its right, title and interest in the plant to F. D. Catlin, N. G. Clark, J. E. McClure, C. E. McConnell and F. H. Reinhold. It is the intention of the new company to run the plant by water power as soon as the proper arrangements can be made to increase its capacity so as to be able to supply lights to the residence houses, and to make other improvements. John Masters has been appointed superintendent of the works.

The Edison General Electric Company, through Second Vice-President Insull, has issued a circular letter to district man-

agers, in which the following is stated: "With reference to the arrangements now being made with the Thomson-Houston company, we desire to assure our employés that the new organization will need the services of every good man now in our employ. It is, therefore, important that every one should continue to make every effort to secure the largest possible amount of business at the best possible price. The combination will doubtless result in ultimately lowering prices to customers on all apparatus, but for the present an agent will be judged, not only for the amount of business secured, but especially by the terms of payment and favorable prices for the same. It is of great importance that no unprofitable contracts be taken, except as may be absolutely necessary to prevent the business going to companies other than the Thomson-Houston company. It is essential that only friendly competition with the Thomson-Houston company should be carried on, and you are requested to report promptly any action on the part of either your own or the Thomson-Houston company's agents that is not in conformity with this end. I shall be very glad if you will convey the substance of this letter to all employés under your control. You will receive due notification from the proper department as to your future course with relation to canvassing for business."

Special Correspondence.

NEW YORK NOTES.

OFFICE OF THE ELECTRICAL WORLD,
167-176 TIMES BUILDING, NEW YORK, April 18, 1892.

The New York Electrical Society, by the courtesy of the Metropolitan Telegraph and Telephone Company, will inspect the Cortlandt Street Exchange, on Thursday, the 21st inst., at 8 P. M. Before the inspection Mr. J. J. Carty, the electrician of the company, will give an address on the working of the exchange.

The Short Electric Railway Company, finding their quarters in the World Building altogether inadequate, have removed to the Mills Building, 35 Wall street. Mr. Edward J. Wessels, manager of the office, and Mr. C. C. Curtiss, confidential agent of the company, are to be congratulated upon their commodious and comfortable quarters and the fine display of railway apparatus which they are placing on exhibition there.

The McEwen Manufacturing Company, of Ridgeway, Pa., have opened offices at 141 Liberty street, Central Railroad of New Jersey Building, this city, and will be represented in this territory by H. H. Hungerford, well known for the past nine years as having been engaged in the engine business. The McEwen company has lately brought out a new automatic engine with such a simple governor that they propose to offer an unusually strong guarantee as to its efficiency.

More Light for the Statue of Liberty.—The total illuminating power of the electric light in the torch of the Statue of Liberty is at present only equal to that of 54,000 candles. A bill has been laid before Congress for an appropriation to increase this to 100,000 c. p. It is stated that the present light is entirely inadequate in foggy weather. Of the 13 arc lights at the bottom of the pedestal only eight are burned on account of the insufficiency of power. A new dynamo was purchased about a year ago and is available for the new plant.

The Western Electric Company has purchased a controlling interest in the Tropical American Telephone Company, and the interests of the two companies will hereafter be cared for in such a manner as not to conflict with each other. The following officers have been elected under the new deal: Chas. N. Hough, president; H. B. Thayer, general manager, and Mills H. Landon treasurer. The offices of the Tropical American Telephone Company, formerly at 95 Broad street, have been removed to 125 Greenwich street.

Dr. J. Graham Scott, president of the Scott Electrical Manufacturing Company, died suddenly Sunday last, of rheumatism of the heart, at his residence, 17 East Twenty-first street, this city. Dr. Scott was forty-two years of age, and was a bachelor. He was born in Philadelphia, and was graduated from the Jefferson Medical College. After practicing in Philadelphia for some years he moved to San Francisco and engaged in electrical studies and enterprises, organizing a private telephone combination known as the Hippocratic Telephone Association. He gave up the practice of medicine several years ago, and moved to this city and organized the Scott Electrical Manufacturing Company. He was well known to many of our readers, and has been an occasional contributor to our columns.

The Electric Light in Theatres.—Among the many devices now employed to utilize the electric light for producing beautiful scenic effects is one which has just appeared at Proctor's Twenty-third Street Theatre to represent a sunrise. A curved scene extends around the stage, part of which is painted on gauze so that light may shine through, and behind it is an elaborate system of incandescent lights. The controlling apparatus is so graduated that 50 different degrees of light and shade can be produced, thus causing the sunrise to grow imperceptibly. Another use of the electric current is to represent the explosion of a bomb. A paper shell contains just enough powder to explode and make a flash. This is fired by electricity, while at the same moment another circuit, controlled by the same key, sets off a gun behind the scenes, which furnishes the necessary noise.

American Institute of Electrical Engineers.—The 66th meeting will be held at the headquarters of the Institute, 12 West Thirty-first street, near Fifth avenue, on Tuesday evening, April 19, at 8 o'clock. A paper will be read by Mr. H. F. Parshall, of Schenectady, N. Y., on "Methods of Electrically Controlling Street Car Motors." The council will meet in the secretary's office at 5 P. M. The annual meeting for the election of officers, the reception of yearly reports, and the transaction of business, will be held at the headquarters of the Institute in New York City, on Tuesday, May 17, and will be followed by a dinner in the evening. The general meeting for the reading and discussion of papers will be held at Chicago, on Monday and Tuesday, June 6 and 7. The headquarters of the Institute during the meeting will be at the Grand Pacific Hotel, Chicago. The programme of papers is now in course of preparation. The Committee of Arrangements at Chicago is as follows: E. M. Barton, chairman, C. A. Brown, Dr. Elisha Gray, W. A. Kreidler and Charles Wirt.

The bill amending the General Railroad Act as to bids for street railroad franchises has become a law. It provides that the right, franchise and privilege of using a street, highway, avenue, park or public place shall be sold at public auction to the bidder agreeing to give for the same the largest percentage of gross receipts. It provides that a bond, to be approved by the Comptroller, must be given for the commencement of work upon the proposed road within one year after the acceptance of the bid and its completion within three years. The bidder must be a duly incorporated railroad corporation in this State, organized to construct and operate a street railroad in the city for which consent may be given. Notice of the sale of a franchise must be given by the Comptroller by advertisement for at least three weeks before the sale. The Comptroller is empowered to cancel a bid if the bidder shall not furnish adequate security upon his bond, or if he may fail in any way to comply fully with the terms of sale, and the franchise may then be resold in the same manner as in the first sale. The railroad company must keep its books always open for inspection. Failure or refusal to pay the stipulated percentage of gross receipts to the city authorizes the Comptroller, after sixty days' notice, to declare forfeited the consent and right to operate the road, such forfeiture to be confirmed by the judgment of a court having jurisdiction.

The General Electric Company Bill Signed.—Gov. Flower has signed the bill incorporating the General Electric Company. The bill imposes a tax of one-twentieth of one per cent. on the capital of the company, the same as in New Jersey, and was introduced by Senator Cantor (Dem., New York) to test the sentiment of the people with regard to giving to corporations organized in this State the advantages offered by the State of New Jersey. The organization tax in this State is one-eighth of one per cent. In approving the bill Gov. Flower says: "The approval of this bill must not be considered as establishing a precedent for future legislation of this character. The measure is approved because it is claimed that its objects cannot well be secured under the general laws, and because its approval will keep within the State a corporation which professes to be ready to invest a large amount of capital, and which, without the concession allowed by its proposed charter, would be incorporated under the laws of New Jersey. The reduction of the tax for incorporation from one-eighth of one per cent. upon the capital stock to one-twentieth of one per cent. is to make the tax uniform with that required by the law of New Jersey, so far as this corporation is affected. The other concessions in the bill are mainly such as have already been incorporated in the amendments to the stock corporation law, which are now pending in the Legislature, and which seem likely to be passed before the close of the session. These indicate a growing sentiment in favor of less severe restrictions in our corporation laws, to the end that the investment of capital may be encouraged within the State. This is in line with the recommendation of my annual message, and reveals a tendency which, in my judgment, is wise, and will result beneficially to industrial and commercial interests." L. H. H.

ALBANY, April 16, 1892.

Ellenville, N. Y., is to be lighted by electricity after May 1.

Lansingburgh.—The residents have petitioned for the use of electricity in lighting the streets, and a committee of the village trustees have the matter under consideration.

Fort Plain.—Representatives of the Westinghouse and National companies have been in town surveying and locating the new lighting plant. Fort Plain, St. Johnsville, Nelliston and Canajoharie will be furnished with light. J. C. Mayer, of Fort Plain, and Irving Miller, of Palatine, are principally interested in the project.

The semi-annual meeting of the directors of the Commercial Union Telegraph Company was held April 13 at the principal office of the company in this city. President Henry Russell said: 'Our lines now comprise over 1,200 miles of poles and nearly 5,000 miles of wire. Over 150 miles of new lines and about 30 new offices have been built and equipped from the earnings during the past year. From the first year of operation we have been growing in strength and prosperity and the prospects for the coming summer are excellent."

Gloversville.—The town has shut down on the Fonda, Johnstown and Gloversville Railroad by refusing its application for change of motive power from horse to electricity. Two other roads are endeavoring to pass through Johnstown—the Cayadutta Electric road and the Johnstown, Gloversville and Kingsboro. The situation has become very perplexing, owing to the demands of the Johnstown authorities. It seems very likely that the F., J. & G. Railroad Company will surrender to the J., G. and K. Railroad Company, and that the Cayadutta company will secure the charter of that road and combine the two in one.

Saratoga Electric Railroad.—The work on the new Saratoga Electric Railroad, which it was proposed to extend to the lake, has been brought to a sudden stop. Inquisitorial proceedings have been begun to determine whether the franchise recently granted by the village was given to an electric railway company or a rapid transit company. It has developed that the parties who are seeking to construct a railway from a point on Lincoln avenue to the race course, and thence to the lake, although somewhat identical, are organized and incorporated in two companies—the Saratoga Rapid Transit Railway Company and the Saratoga Union Electric Street Railway Company. It is questioned whether the road had the consent of the required number of property holders when the franchise was given. R. V. T.

NEW ENGLAND NOTES.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
Room 28, Hathaway Building, 620 Atlantic Ave.,
BOSTON, Mass., April 18, 1892.

Mr. C. A. Bodwell, superintendent of the Sanford Electric Light and Water Company, Sanford, Me., has been the guest of the Eastern Electrical Supply Company.

The W. S. Hill Electric Company, of Boston, is sending out a neat circular showing illustrations of its switches, and announce that this price list supersedes all former ones.

The Consolidated Electric Manufacturing Company has been attracting considerable attention among street railway men with the Lyon brake, which is claimed to be practically indestructible.

The West End Street Railway Company expects to have its Charlestown division equipped for electric service early in May. It is stated that the proposed issue of 40,000 shares of new stock may be made also next month.

The Heymann Arc Lamp, manufactured by the Consolidated Electric Manufacturing Company, Boston, attracts the immediate attention of arc lamp users on account of its many attractive points, such as absence of clockwork, gearing, etc. Perfection of feeding mechanism, absolute steadiness and constancy of arc, simplicity of construction and economy of illumination, adaptability to direct circuits of any voltage or alternating circuits are points claimed.

West End Railway Changes.—The following changes in the operation of street car lines go into effect: The Dorchester street and South Boston line to the North Depots will be operated by electricity. The route will hereafter be the same as now used by the present horse lines. The Forest Hill electric line now running to the Tremont House will be extended to the Northern Depots. One half of the cars now run between Jamaica Plain and Northern Depots will stop at and return to Tremont House.

Electric Car Fenders.—A trial has been made at Grove Hall in the presence of the Fender Commission of the West End Road and the Legislative Committee on Railroads, of electric car fenders. The devices tried were the Sullivan, the Sargent, the Monks, the Cleveland, Standard, the Kansas City and the Morse or Bash. All were tested with dummies representing a man, a woman and a child, and while there were differences in the amount of mangling an individual might receive if placed in similar circumstances, it was quite clear that neither could justly be called safe and practicable. There were three types of construction—the net projecting beyond the car, the flat shelf similarly projecting, and the perpendicular net from the dasher to the track. Each had a device behind itself to prevent the wheels from crushing a victim, but it did not seem to work with success. The test was instructive in that it illustrated the lines of effort in which the inventors are working.

W. R. W.

WESTERN NOTES.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
465 THE ROOKERY, CHICAGO, April 16, 1892.

Mr. James R. Dee, of Houghton, Mich., visited the World's Fair buildings this week.

Mr. Ernest Hoefer is nicely located in his new and handsome office, 1,222 Monadnock Building, Chicago.

Mr. J. A. Long, President of the Akron Iron Company, of Akron, O., was a welcome visitor in Chicago on Wednesday.

Mr. William R. Allen has opened an office for general contracting and construction work at 225 Dearborn street, Chicago.

Mr. W. C. McKinlock and Mr. F. B. Hill, of the Southern Electric Supply Company, of St. Louis, are Chicago visitors this week.

The Chicago Edison Company has secured the property on the corner of Charles and Harrison streets, 230 × 280 feet, for $190,000.

Mr. C. D. Crandel, manager of the Western Electric Company, Chicago, left for New York, Wednesday afternoon, on a flying business trip.

Mr. D. F. Urquhart, of the Thomson-Houston Carbon Company, favored with his presence the Victoria, Chicago's new hotel, on its opening day.

Mr. Clift Wise, of the Interior Conduit and Insulation Company New York, greeted his Chicago friends on Wednesday, having stopped over on a flying trip.

George Cutter, the Western selling agent of the Simplex Electrical Company, will furnish Simplex wire for the new German Opera House, on Randolph street, Chicago.

The New York Insulated Wire Company has had its specialties thoroughly advertised in the West by Mr. J. W. Godfrey, who has been hustling around in his usual active manner.

Mr. Richard Bohnen, a well known mechanical engineer and draughtsman, 555 The Rookery, Chicago, is now engaged in preparing the plans and specifications for an extensive water power plant.

Mr. George H. Meeker, Chicago manager of the New York Insulated Wire Company, has gotten up a very attractive new letter head, on which the specialties of his company are prominently placed.

Mr. George L. Kirkham, the Chicago representative of the Economic incandescent lamp, who is in daily receipt of orders for the excellent lamp he is pushing, is now reaping the benefit of the missionary work he did a year ago.

George W. Westinghouse, Jr., representing the Westinghouse Electric Company, appeared before the committee on grounds and buildings recently and asked the committee to reopen their bidding, but his request was denied.

The National Board of Fire Underwriters has decided to adopt more stringent measures to prevent the use of any but the highest grade of insulation wherever electric light wires approach, or enter, or are placed within buildings.

Mr. F. H. Leonard, of the Electrical Engineering and Supply Company, of Syracuse, N. Y., who is swinging around the western circle, is as genial and contented as any man naturally would be who has his pockets full of profitable orders.

Mr. W. R. Mason, president and general manager of the Electric Merchandise Company, has resigned, and Mr. W. L. Adams has also resigned as secretary and treasurer of the same company. They have opened offices temporarily, until May 1, at 617-619 Pullman Building.

Mr. Eugene A. Erich, the well known consulting and contracting mechanical engineer, of 438 The Rookery, Chicago, who is representing the Waddell-Entz Electric Company, in Chicago is pleased with the cordial reception everywhere accorded the excellent apparatus his company is promptly delivering.

The Nubian Iron Enamel Company, of Cragin, Ill., is sending out the quarterly desk pad that busy men have found so convenient in expediting business. The top portion of each leaf has been utilizing in calling attention to some of the merits of Nubian enamel and paints in some pointed paragraphs.

Mr. J. L. Barclay, who has always been the principal stockholder in the Electric Merchandise Company, has assumed the management of that well known electric railway house. Mr. Barclay's widely known reputation as a successful business manager can not help but add materially to the strength of the company.

Mr. John P. Barrett, Chief of the Department of Electricity of the World's Fair, returned from New York on Wednesday, where he transacted business of importance for his department. Mr. Barrett states that there is no foundation in the newspaper report that he was about to resign his various responsibilities in Chicago and move to New York.

Mr. George R. Tuttle, consulting engineer of the Alaska Coal Company, 216 and 218 Sacramento street, San Francisco, Cal., is now in Coal Bay, Alaska, making surveys and preparing estimates for permanent work, and also considering the advisability of application of electricity for whatever power service may be required in operating the mines.

The Chicago Electrical Association.—Prof. C. S. Cook, of the Northwestern University, was greeted by a large and appreciative audience on Tuesday evening on the subject of Hertz's experiments in the association rooms. The membership of the association is steadily increasing, and it bids fair to become one of the most useful organizations in the West.

The Chicago Telephone Company will furnish 300 instruments to the World's Fair building at a rental of $25 a quarter, while private subscribers will only pay the usual rates given in the city, the telephone company to do all the wiring at their own expense. It is expected that a large source of income to the telephone company will be the public exchanges, where a fee of 10 cents will be charged.

The Railway Equipment Company is a new Western organization, with offices in the Pullman Building, Chicago. Mr. W. R. Mason and Mr. W. L. Adams, late of the Electric Merchandise Company, are the active members and the stockholders are said to be among the principal capitalists in New York and Chicago. Their specialty will be the handling of electrical supplies for any and every system of electric railways.

Exposition officers have agreed to award the contract for furnishing the entire incandescent electric lighting plant of 93,000

lights for the exposition to the Edison General Electric Company at $5.95 per light. The price previously submitted by the companies bidding was $18.50 per light, which would have made the plant cost $1,720,000. As it is, the plant will cost approximately $553,000, making a saving of nearly $1,200,000.

Mr. J. H. Rhotehamel, president of the Columbia Incandescent Lamp Company, St. Louis, Mo., is one of the welcome visitors in Chicago this week. Speaking of the business outlook, Mr. Rhotehamel states that his company is in receipt of a greater number of orders than ever bef ore v this season of the year, and believes that the total volume of business for the present quarter will far exceed that of the second quarter of 1891.

Mr. E. L. Babcock, President of the Falls Rivet and Machinery Company, Cuyahoga Falls, O., was quartered at the Grand Pacific this week, and in referring to business affairs Mr. Babcock said that his extensive works were crowded with orders, and that the work already contracted for and that now being planned, indicated that 1892 would be remarkable for the amount and number of electrical installations requiring heavy transmission machinery.

France, through its Consul at Chicago, has asked for 20,000 square feet of space in the Electricity Building. It was awarded about 6,000. The Consul based his demand on what had been granted Germany, which is 20,000 square feet; but Germany's allotment was made six months ago, before the management had any appreciation of the demands that would be made. It is not improbable that the big allotments made to Germany and England in all the buildings will have to be scaled.

The Collection of Accounts.—Mr. E. C. Ferguson, a well known counselor-at-law, and a prominent member of the Chicago Electric Club, and Mr. Charles N. Goodnow, a popular young attorney, comprise the firm of Ferguson & Goodnow, of 84 La Salle street, who have for several years made a specialty of the collection of electrical accounts with more than average success, and are now handling a large share of the work for the leading electrical companies, a business that has been won by persistent hustling, perseverance and a strict accountability in every detail.

Chicago Electric Club.—The members gathered at the rooms on Monday evening to listen to a debate on the question, "Should We Have the Trolley in Chicago?" after which Mr. Elmer A. Sperry and Mr. B. T. Arnold presented the following resolutions covering the death of Charles J. Van Depoele: *Whereas*, The Chicago Electric Club learns with sorrow and regret of the death of our former member and fellow townsman, Chas. J. Van Depoele; and *Whereas*, The electrical fraternity has lost a skillful and energetic engineer, and the club a true and faithful friend; and *Whereas*, His work and efforts were always in the line of progress and the practical development of electrical science along paths hitherto untrodden, and which have led in our own day to results of great utility and benefit to the public; therefore be it *Resolved*, That the Electric Club of the city of Chicago desires to place on record the testimony of its respect and appreciation for the labors, ability and genius of the deceased, and that it hereby tenders to his family and friends its sincere sympathy in their bereavement and irreparable loss; and be it further *Resolved*, That the secretary of the club be instructed to transmit a copy of these resolutions duly engrossed to the family of the deceased, and spread the same upon the records of this club. F. Del.

Tacoma, Wash., April 12, 1892.

Mr. Frank Cannoll, of San Francisco, general manager of the Pacific Phonograph Company, was recently in Tacoma.

The Edison General Electric Company has sold a small electric light installation to the Ainslie Mill Company, for its mill in Lewis County, Wash.

Mr. H. W. Goode, of Portland, Ore., district manager of the Northwestern Thomson-Houston Electric Company, was recently in Tacoma on important business.

The Tacoma Light and Water Company has recently added to its circuits 40 arc lights, formerly operated by the Commercial Electric Light and Power Company.

The American District Telegraph Company's Seattle Branch has ordered 400 additional return bell messenger calls. One thousand two hundred call boxes are already in use.

The Tacoma Railway and Motor Company is setting up in its power station a new Edison 175 k. w. railway generator. The equipment of the station will be doubled in capacity in the near future.

The Grant Street Railway Company, of Seattle, is still laying track on its extension, and it has reached the drawbridge across the Duwamish River. This line now has a 15-minute service to the race track.

F. L. Dame, district construction engineer of the Northwestern Thomson-Houston Company, who will have charge of the overhead construction of the Pt. Defiance Tacoma and Edison Company's line, will transfer his headquarters from Portland, Ore., to Seattle.

The West Street and North End Railway Company, of Seattle, D. H. Gilman president and manager, is giving a fine service from the water front of the city to the suburb of Ballard, and a high rate of speed can be maintained on a large part of the line.

The City and Suburban Railway Company, of Portland, Ore., is making good progress on the overhead construction of its Third street line, which is being equipped to use electricity. This company will have 50 electric cars in use on its combined lines this summer.

The Northwestern Thomson-Houston Electric Company, through H. W. Goode, district manager, has been doing a phenomenal business this month, the contracts, including one for five car equipments for a railway in Portland, Ore., having aggregated nearly $200,000.

Mrs. Annie Sears, who was injured by the collision of a Seattle Consolidated Street Railway car with a wagon, last September, was recently awarded $15,000 damages by the jury in the Superior Court. It is expected that a motion for a new trial will be made by the railway company.

Electrician Arnold, of the A. F. Esperson Company, recently returned from San Francisco, where he arranged for the manufacturing of the Arnold flexible bracket for incandescent lamps. The company is overrun with orders and flattering offers to take State rights for the invention.

The Snohomish & Everett Electric Railway line is being graded rapidly under contract. The syndicate of Snohomish citizens, headed by Mayor Ferguson, who are promoting the project, have obtained a franchise on Pacific avenue, in Everett, for the road, which is eight miles in length.

The Union Trunk Line Company, of Seattle, E. F. Wittler manager, has ordered a 240-h. p. railway generator of the Northwestern Thomson-Houston Electric Company. The new passenger station at the James street power house is being pushed to completion, and the rearrangement of the tracks is finished.

The Tacoma and Stellacoom Railway Company will expend $8,000 or more in erecting and fitting up a club house with restaurant attached at the Steilacoom terminus. The local officials have received orders from the East to arrange for the buildings, lay out pleasure grounds and provide sailboats, etc., for the purpose of increasing the travel over the electric line.

The Seattle Consolidated Street Railway Company, L. H. Griffiths, president, has closed a contract with the Northwestern Thomson-Houston Electric Company for ten W. P. car equipments. A new time schedule has gone into effect on the company's lines, giving a ten-minute service on the North Seattle, Lake Union & Cedar Street lines, and a five-minute service to passengers for points south of Cedar street. G. R. Dev.

CANADIAN NOTES.

Ottawa, Ont., April 15, 1892.

Port Arthur, Ont.—The electric railway between this town and Fort William has been completed and the cars are now running.

Quebec, Canada.—The city clerk is asking for bids for city electric lighting, the bidder to put in the plant, apparatus and everything complete. Bids will be received until May 4.

Peterborough, Ont.—The latest contract made by the town with the Peterborough Light and Power Company calls for 75 arc lights to burn all night at the rate of 25 cents a night, which, omitting moonlight nights, amount to $75 a year.

Ottawa, Ont.—A new car has arrived from Philadelphia for the Electric Railway Company. It cost $1,500 and is claimed to be the finest that ever entered Canada. It will take the road Thursday or Friday. The interior is finished in natural cherry and beautifully upholstered.

Charlottetown, P. E. I.—Default having been made in payment of the semi-annual interest due under the bonds of the Prince Edward Island Electric Company, the property, station, plant and franchise of the company have been seized and are advertised to be sold at public auction on April 22.

Montreal, Can.—A syndicate, which includes H. E. Everett, who controls the Cleveland, Cincinnati and Toronto street railways, has acquired a controlling interest in the Montreal street railway, and proposes to introduce an electric system here. It is understood the syndicate has in view the acquirement of all the street railways in the Dominion.

Victoria, B. C.—A. Shaw's electric light works have been floated into a joint stock company with a capital of $75,000. Twenty-five per cent. will be retained by Mr. Shaw and the rest is taken up in New York, Vancouver and this city. Mr. Shaw feels that with the Edison company at his back the present works will be one of the best on the coast. Nearly all the streets in the city have been lit up.

Hamilton, Ont.—The conference between the promoters of the Hamilton, Grimsby and Beamsville railway and the sub-committee was highly satisfactory and the road will be built. Concessions have been made by the street railway company, and the committee will grant the Hamilton, Grimsby and Beamsville company the right to run local trains from the corner of James and Maine streets, instead of from the corner of Caroline and Stuart streets.

Port Arthur.—At a meeting of the City Council recently the Mayor read a letter in the shape of a motion addressed to Clerk Rutledge, of Neebing, setting forth the proposed route of the street railway through Fort William. The route mapped out is from the present terminus to Sampson street, thence to Victoria avenue, thence to Syndicate avenue, thence to Main street, to Hector street, to Victor street, to Spragge street, to Fredereca street to the P. A., D. & W. right of way.

ENGLISH NOTES.

(From Our Own Correspondent.)

London, April 6, 1892.

German Thomson-Houston Company.—There are rumors that the Elektricitäts Gesellschaft Union, which, being interpreted, is the German Thomson-Houston Company, proposes to follow the example of its American parent and swallow up as many of the small electrical fry as it can.

The Chicago Exhibition.—The announcement of the Electrical Committee of the Royal Commission for the Chicago Exhibition that there is a possibility of some portion of the exhibition electric lighting being undertaken by English firms has given general satisfaction. A request for a substantial increase in the government grant is also engaging the attention of the House of Commons.

Lane-Fox Distribution Patent.—Mr. Justice Smith has given judgment in the action brought by Mr. Lane Fox against the Kensington and Knightsbridge Electric Lighting Company, his decision being in favor of the defendant company. Mr. Lane-Fox alleged that the company infringed his patent No. 3,988, of 1878, which, according to him, covered parallel distribution with storage batteries as "reservoirs of electricity." This contention is now no longer a bugbear to low pressure supply companies.

"Drehstrom" Transmission.—I hear that the Lauffen-Heilbronn "drehstrom" transmission plant is now working regularly. Current is supplied from the turbine station at Lauffen by a 50 volt 4,000-ampère Oerlikon dynamo. The voltage is transformed up for transmission to 5,000 volts and down again at Heilbronn by two steps to 100. The fluctuations of pressure were at first somewhat excessive, being about 8 per cent. It is a remarkable fact that oil insulation has been dispensed with in all the high pressure converters. The reason for this step is not as yet forthcoming.

Electric Traction in England.—In the course of the discussion on Mr. A. Reckenzaun's paper before the Institution of Electrical Engineers on "Load Diagrams of Electric Tramways and the Cost of Electric Traction," Mr. Graff Baker made some statements with regard to the Thomson-Houston line at Leeds, which were listened to with great attention. The interest of Mr. Graff Baker's remarks lay in the fact that they were a frank confession of his surprise at finding that English conditions were *really* totally different to those which obtain in the United States Mr. Graff Baker also made a favorable impression by the candid way in which he detailed his expenses at Leeds, where the cost per car mile, as the line is now worked, comes out at about 6½d. Mr. Graff Baker rightly pointed out that in stating the cost per car mile it was highly desirable to specify the nature of the car, since they varied from 16 to 32 feet in length, with corresponding variations of weight and passenger accommodation.

Cost of the Electric Light in Mills.—Some remarkable figures have lately been published with regard to a 150-light installation in some large steam mills in Barrow-in-Furness. The installation was laid down in 1885, and includes a Mather & Platt dynamo, driven off countershafting from a horizontal Marshall engine, supplied with steam at 65 pounds pressure from the mill boilers. Taking the average for the six years, we have the following figures: Annual cost, £92; cost per lamp hour, .059d. The price of gas in Barrow being three shillings per thousand, the annual cost of an equal number of No. 5 burners consuming 5½ cubic feet per hour would be £314. If we take the 16 c. p. Edison-Swan lamp as consuming on the average 80 watts, the lamp hour at .059d. is equivalent to the Board of Trade unit at ¾d., the price charged per unit in London being 7d. to 8d. The average life of each lamp at this phenomenal mill comes out at 3,484 hours, and there are two or three of the originally installed lamps still burning which have run for 20,000 hours.

Inquiries from Correspondents.

Queries to be inserted in this column must be of general electrical interest, and must be accompanied by the real name and address, not necessarily for publication, but as a guarantee of good faith. No notice will be taken of questions which involve nothing more than can be found in elementary treatises on the subject. All correspondence should be as brief as is consistent with clearness. Readers are invited to send discussions and answers to these questions, which will be inserted in the column below.

[70.] What are the customs duties on electrical supplies? A. M.

[71.] In a shunt or series wound dynamo, how does a variation of the speed affect the volts and ampères, the resistance of the main and field circuits remaining constant? C. A. R.

[72.] What number of wire should be used for a ground from a Thomson-Houston lightning arrester on the transformer system? M. C.

[73.] What is the best way to ground wire when gas or water pipes are not available? M. C.

[74.] For the care of an ordinary Ruhmkorff coil would not compressed soft iron filings give as efficient a result as soft iron wire? L. D.

[75.] In constructing an induction coil should the length and resistance of the primary be directly proportional to the secondary, and if so please state proportions? L. D.

[76.] Is paraffined paper any better for insulating layers of wire than cartridge paper; also will not white shellac do as well for treating each layer of wire as melted paraffine? L. D.

[77.] Would the inductive effect be increased by reversing the direction of each layer of wire in the primary or secondary coils? L. D.

[78.] Would an automatic current reverser placed in circuit between battery and coil produce any appreciable improvement in length of sparks given by coil. L. D.

[79.] How heavy wire is it practicable to use in the primary coil; also, is not a long small diameter coil more efficient than a short thick one? L. D.

[80.] In the overhead trolley system, Westinghouse, for example, are the rails and ground used as a return for the current, or the rails alone? G. F.

[81.] What is the object of the wire at the junction of each rail? G. F.

[82.] Could any form of storage battery now made be charged at an electric light or power station and be economically used by persons residing within a radius of 10 or 15 miles for lighting or for power? J. S. C.

[83.] Why is it that incandescent lamps cannot be run at a considerable distance from a transformer, thus necessitating the use of so many small transformers? J. S. C.

[84.] What is used for paste to coat or fill the grid in storage batteries, and what liquid is used to mix it? W. E. D.

[85.] Are both positive and negative plates treated with the same paste or should it be made of different material? W. E. D.

Answers to Correspondents.

Readers are invited to send discussions regarding or answers to the queries published in the column above, or with regard to any other live questions on electrical subjects. In answering questions please refer to them by their serial number. Correspondence must be accompanied by the real name and address, not necessarily for publication, but as a guarantee of good faith. All correspondence should be as brief as is consistent with clearness. The Electrical World *assumes no responsibility for the opinions expressed by correspondents.*

[22.] The thermo-electric value in micro-volts, referred to lead at any temperature $t°$ (centigrade) of aluminium is $.77 - .0039\,t$, of palladium $6.25 + .359\,t$, and of an alloy of platinum and nickel $5.44 + .011\,t$. H. W.

[22.] Taking the E. M. F. between silver and copper as equal to 1 the thermo-electric values in micro-volts between silver and each metal for temperatures between 40° and 100° C. is for palladium + 3.56, aluminium + 1.283 and platinum + 0.723. H. P

[37.] The constant 16.024 is obtained by the substitution of the value of C in formula 3. It is the product of 746 and 21.48. H. W.

[38.] Aluminium and aluminium bronze are both good conductors, the specific resistance of the former being 1.1845 times that of copper. C. D.

[42.] The two windings assist each other. There is no fixed rate of resistance; the series coils usually furnish from one-sixth to one-third of the total exciting power applied to the field. C. P. P.

[43.] A dynamo giving 100 k. w. at the brushes will require from 115 to 152 h. p. applied at the pulley, according to the design of the machine. C. P. P.

[44.] The electric car requires more horse power because the car drawn by horses weighs only about one-fourth as much as that operated by electricity, and travels at from one-tenth to one-third the speed commonly attained by the latter. C. C. P.

[46.] The ordinary 52 volt 16 c. p. lamp requires about one ampère. If the resistance of a lamp is known the current required can always be found from Ohm's law by dividing the electromotive force by the resistance. H. W.

[47.] For a brief treatment of alternate currents see one of the Van Nostrand series by Kapp; for the mathematical side see Fleming's "Alternate Current Transformer," Vol. I. The second volume of this work, dealing with the practical side, is now in preparation. C. D.

[48.] A choking coil will not operate with direct current. C. P. P.

[49.] Unless the electromagnet is very strong compared with the permanent magnet, and they are close to one another, the latter is not likely to be affected. The D'Arsonval galvanometer, which contains a permanent magnet, will work well when placed beside a dynamo. A. B.

[51.] It is not the porous cups or carbons that give out in a Leclanché cell, it is the manganic di-oxide which the cup contains. A good plan is to remove the wax covering, empty out the manganese into a vessel and let it stand until all the hydrogen in it has been dissipated. This will not be very satisfactory. The best plan is to use a cell without a porous cup. J. S. S.

[51.] The porous cups and carbons of a Leclanché cell may often

be renewed by boiling in water fifteen or twenty minutes. If this does not do, substitute new cups and their contents.

C. W. VAN L.

[52.] When a conducting tube is placed around the coil, currents are induced in it whose effect on the secondary is always in opposition to that of the primary, thus tending to neutralize its effect on the secondary. C. W. VAN L.

News of the Week.

THE TELEGRAPH.

A New Transatlantic Cable.—The steamer Silvertown will sail from London about May 1 with over 2,000 miles of telegraph cable, which she will lay between St. Louis (Senegal, West Africa) and the island of Fernando de Noronha, about 125 miles from the Brazilian coast. Connecting cables will be laid from Fernando de Noronha to Pernambuco, and from St. Louis to Teneriffe, joining at the latter point the cable of the Spanish National Company to Cadiz. This will make a new line between Europe and South America.

THE TELEPHONE.

Annapolis, Md.—The Telephone bill, with amendments, passed the house by a vote of 76 to 8, and has been signed by the Governor. There was little opposition to the bill at the last. It reduces rates to $75, a reduction of 40 per cent. It is said that public sentiment will force Governor Brown to veto the reassessment bill.

A New Telephone Bill.—The bill introduced in the New York Legislature by Mr. Aspinall creating a State Telephone Commission of one Republican, one Democrat and an electrician, to be appointed by the Governor, to serve two, three and four years, has passed the Senate. The board is to have power to regulate telephone charges, is to have its headquarters in Albany and to meet at least once a month.

Telephone Patent Suits Compromised.—The cases of the American Bell Telephone Company and the Western Electric Company, against the Viaduct Manufacturing Company of Baltimore city, A. B. Davis and Augustis G. Davis, pending in the United States Circuit Court for infringement of the patents of the plaintiffs by the defendants, has been adjusted, it is stated, by negotiations between the parties. The agreement provides for decrees in the cases for permanent injunctions, restraining the defendants from further infringements and fixing the damages at a nominal sum.

To Regulate Telephone Charges.—A resolution has been introduced before the House Committee on Patents intended to produce a bill to regulate and reduce telephone charges, a result of the agitation against excessive telephone charges in Washington and various States. Friends of the telephone companies claim to only interstate lines can be controlled by Congress, while the representatives of the people hold that inasmuch as the telephone is maintained by patents created under laws of Congress the latter may prescribe rules and regulations for the control of the telephone within the States, as well as those running interstate.

THE ELECTRIC LIGHT.

Dresden, O., has voted to establish an electric light plant.

Orange City, Ia.—The city is agitating the electric light question.

Oak Harbor, O., contemplates the establishment of electric lighting.

Etna, Pa., will issue $25,000 bonds to establish an electric lighting system.

Moberly, Mo.—The City Council is seeking information about electric light plants.

Waitsburg, Wash.—The city is contemplating the establishment of an electric light plant.

Plymouth, Mass.—The Plymouth Electric Light Company contemplates enlarging its plant.

Richmond, Va., will vote on the question of appropriating $125,500 for an electric light plant.

The Boston Electric Light Company has agreed to establish an incandescent electric light plant in East Boston.

Laurel, Del.—The question of establishing an electric light plant is being considered with good prospects of the same being accomplished.

Syracuse, N. Y.—The Onondaga Electric Company has been granted a franchise to supply the town and People's Railway with electric power.

Richmond, Va.—The Committee on Finance and Electric Lights will consider the appropriation of $125,000 for the erection of an electric light plant.

Gladstone, Mich.—A franchise has been granted to Edwin S. Tice and others for an electric light and power plant to be in operation within 30 days.

Granite Falls, Minn.—The City Council has entered into a contract, it is stated, with E. T. Sikes, of Minneapolis, for the erection of an electric light plant.

Carlisle, Pa.—The electric light plant is inadequate to meet the demands of the city and another dynamo will be added. It is also the intention of the company to erect a new and larger building.

Wilmington, Del.—The Wilmington Gas Light Company's bid for lighting the city was referred to the committee on lights. The company offered to furnish 65 arc electric lights for $10 per month for each light.

Cornwall, N. Y.—The electric light company of this place has placed before the Council a proposition to furnish 72 twenty-five candle power electric lights for five years, with a moonlight schedule for the annual sum of $1,445.

Hampton, Va.—The Chesapeake Light and Power Company has been awarded the contract for furnishing the arc lights for street lighting. Work on the plant is to be pushed and it is expected that it will be ready for operation by May 1.

Morgantown, W. Va.—The contract for the central station lighting plant here has been awarded to the Edison General Electric Company, Pittsburgh, Pa. The plant is to consist of 1,000 incandescents and 20 arc lights. Work is to be begun immediately and completed by June 1.

Duquesne, Pa.—An Edison central station is to be erected at this point, and the contract has just been awarded to the Edison General Electric Company at Pittsburgh. The franchise which was so long held in abeyance was finally passed and signed at a recent meeting of the City Council.

The Monticello Electric Light Company, of Monticello, Ill., consisting of H. Benson, W. H. Kratz, C. A. Tatman and others, will put in a new $40,000 electric plant at Decatur, the city having granted a franchise. The Decatur Gas Light and Electric Light Company, in turn, proposes to erect another plant at Monticello, it is stated.

Denton, Tex.—W. J. Williams, Dallas, Tex., has been granted a franchise for water supply and electric lighting at Denton, Tex., and has organized the Denton Water-Works and Electric Light Company. He has contracted with the Dallas office of the Pond Engineering Company for two 70-h. p. steel boilers, which will be erected at once.

Denver, Colo.—The Denver Electric Company has been organized by ex-Governor Cooper, C. L. McIntosh and Geo. W. Trimble. The company will erect poles and wires and place wires underground in nearly all streets and alleys in the city. A plant will be erected of 1,000-h. p. to furnish both arc and incandescent lights for the city.

To Have the Electric Light.—The following towns and cities are considering the question of electric lighting: Henry, Ill.; Blackstone, Mass.; Cisco, Tex.; Seymour, Ind.; Homer, Ill.; Gladstone, Mich.; Chamberlain, S. Dak.; Londonville, O.; Washington, Ky.; Canton, Miss.; Manatee, Fla.; Dayton, Tenn.; Manchester, Mich., and Ridgewood, N. J.

Westminster, Md.—The Electric Light Company, of Carroll county, has been organized with a capital stock of $15,000. The officers are: Charles E. Steward, president; H. Steward Roberts, vice-president; A. H. Huba, secretary; Fred D. Miller, corresponding secretary; Charles E. Fink, treasurer. The plant will be put in at once, and will be used for lighting purposes and also for power.

THE ELECTRIC RAILWAY.

Cumberland, Md.—The City Council has authorized the electric railroad to extend its tracks.

Bellevue, Pa.—The Council has granted the Mount Pleasant Valley Railway Company permission to extend its tracks.

Annapolis, Md.—A bill has passed the Senate incorporating the Electric Light and Railway Company of Baltimore County.

Gettysburgh, Pa.—It is proposed to run an electric road over the battlefield, which will be eight miles long and cost $170,000.

Columbus, O.—A syndicate of New York and Philadelphia capitalists has purchased the electric street car lines of this city.

Taunton, Mass.—The proposed electric railway company to be organized in this place will lay tracks from here to Providence.

Washington, D. C.—The Commissioners have reported favorably to incorporate the East and West Washington Railway Company.

Denver, Colo.—The officials of the Denver, Lakewood & Golden Railroad are contemplating the construction of a five mile road to Fort Logan.

Cumberland, Md.—An ordinance has been passed authorizing the electric railway company to lay its tracks across the new bridge.

Manchester, N. H.—The railway company here contemplates extending its tracks and changing its motive power from horse to electricity.

Omaha, Neb.—The Omaha Street Railway Company will make arrangements for additional service and extension of its lines on North street.

Troy, N. Y.—The Troy & Lansingburgh Railroad will change its motive power from horse to electricity, and will run its lines from Troy to Cohoes.

Brockton, Mass.—The Brockton Street Railway Company has leased the Whitman Street Railway for 99 years, and will improve the road.

Bath, Me.—The Bath, Small Point & Popham Beach Street Railway Company has been granted right of way through certain streets of the city.

New Haven, Conn.—Permission has been granted the New Haven and West Haven road to use the electric trolley system, the poles to be of iron or steel.

Media, Pa.—It is proposed to connect this place with Chester by a trolley railway. Samuel A. Dyer, president of the Union Railway Company, is interested.

Lowell, Mass.—The Lowell & Suburban Street Railway Company has been granted permission to lay additional tracks and to use electricity as a motive power.

Middletown, Pa.—Work on the Steelton, Highspire and Middletown Electric Railway is being pushed rapidly, and it is expected the road will be completed and in operation by June 1.

Catskill, N. Y.—It is contemplated to build an electric railway from the mountain terminus of the Otis road to Haines Falls or possibly Tannersville by way of Hotel Catskill and the Laurel House.

Boston, Mass.—Boston & Revere Electric Railway Company proposes to increase its capital stock from $100,000 to $150,000 and to extend its line from Revere to Winthrop, Beachmont, to connec with the Boston lines.

Cincinnati, O.—John J. Shipherd is one of the syndicate of Cleveland capitalists who purchased the control of the South Covington & Cincinnati Electric Railroad. The plan contemplates extensions and improvements to cost several million dollars.

Tiffin, O.—Tiffin will have an electric street railway. Meshech Frost, Judge J. F. Bunn and Frank Bloom, of Tiffin, and F. W. Brightman, of Fall River, Mass., have organized a company for that purpose. They will apply for a charter and begin work as soon as the right of way and franchise can be secured.

An Electric Road at Gettysburg.—The historic battlefield of Gettysburg will soon be made accessible by an electric railroad. The line takes in all the important and historic points of the entire second and third day's fight. The length of the road will cover eight miles, and the cost will be about $170,000. Stations will be erected at most of the important points.

The Indianapolis Street Railway Company, of Indianapolis, Ind., has been incorporated with a capital stock of $1,560,000. The directors are Edward F. Leonard, John U. Bunn, Edwin N. Armstrong, Enos D. Usher and Augustus L. Mason. The incorporation is supposed to be the first step in the purchase of the Citizens' Street Railway of Indianapolis from its Chicago owners.

The Ossining Electric Road.—The incorporators of the Ossining Electric Railroad, which is the name of a new company to operate an electric railroad in Sing Sing, at a recent meeting elected the following officers: President, Edwin A. McAlpin; vice-president, John V. Cockcroft; treasurer, A. S. Underhill; secretary, F. D. Arthur. Executive Committee—E. A. McAlpin, S. E. Tompkins and William Brandreth. The capital stock of this railroad is placed at $50,000, 500 shares at $100 each.

PERSONALS.

Dr. Louis Bell is making a tour of the Western States and expects to return to New York about the first of May. He is at present in Denver, where he has just returned from spending a few days on the Pacific coast.

Mr. S. M. Wheeler, who is well known in electrical circles as has associated himself as one of the firm of the Iron City Electric Company, of Pittsburgh, Pa. This company does an extensive business in central stations, isolated plants and general electrical contracting; also dealing in all kinds of electrical supplies. Mr. Wheeler will be of great assistance to the already prosperous business of the company.

Frederick Willard Baldwin, general wire chief of the Western Union Telegraph Company, died at his home, 369 East 135th street, on April 13. He was born in Weedsport, N. Y., Nov. 21, 1852. At the age of 13 he became a messenger boy, and after three years' employment along the line of the New York Central he came to New York City and entered the service of the Western Union as an operator. He advanced rapidly until ten years ago, when he was made chief over all the wires. Mr. Baldwin had a wonderful memory and was thoroughly familiar with all the details of the work. At the time of the great fire in the operating room, when his knowledge did more than anything else to restore the system, he caught a severe cold, which was the ultimate cause of his death. Mr. Baldwin was a member of all the telegraphers' clubs and societies.

MISCELLANEOUS NOTES.

Swansea, Mass.—The works of the Althair Motor Company were destroyed by fire on the night of April 12.

Washington, D. C.—The House has passed an amendment to to a street railroad bill providing that passengers who cannot get seats in the cars but are willing to pay for the privilege of standing up, will not be allowed to do so, but must walk. An amendment permitting the use of the trolley on some of the streets of Washington was also passed.

A new electrical journal, or rather an old one with a new name, has reached us from Boston. Its editor and proprietor is Mr. R. F. Ross, who formerly occupied the same position on *Modern Light and Heat*, the predecessor of the new paper. The publication is to be especially devoted to electrical progress and development in New England, a field in which there is abundant material for a first class journal. The title chosen for the new journal is *Electrical Progress and Development*, and it will be issued once each month.

Industrial and Trade Notes.

Mr. Charles A. White, the Pittsburgh representative of the Eco Magneto Clock Company, of Boston, states that his business is better than ever and the outlook for the future very encouraging.

Baker & Co., gold and metal refiners, of Newark, N. J., recently had their office entered by burglars, who attempted to force open the two safes in the office, which contained a large quantity of platinum. The attempt was unsuccessful.

A. Allen, of 109 Liberty street, New York, dealer in engineering specialties for steam, water, gas, oil and chemical purposes, is sending out a neat 56-page illustrated and descriptive price list and catalogue of the large line of these specialties which he handles.

The Bryant Electric Company, of Bridgeport, Conn., has acquired from Herbert C. Wirt and James I. Kimball the exclusive license under letters patent of the United States No. 407,077, dated July 16, 1889, and No. 431,062, dated July 1, 1890, to manufacture and sell the K. W. ceiling rosettes and fuse blocks.

The Pittsburgh Reduction Company has removed its offices and storeroom from 95 Fifth avenue to 116 Water street, where a storeroom of aluminium, sheet, wire and ingots, will hereafter be kept. All correspondence should be addressed to 116 Water street, Pittsburgh, Pa., and all supplies should be sent to New Kensington, Pa.

Machinery Wanted.—Mr. C. Boettcher, of the Denver Electric Company, 210 People's Bank Building, a new company which has recently been started in Denver, Col., in a recent communication to THE ELECTRICAL WORLD states that his company is in the market for electrical machinery, and will entertain all bids from manufacturers.

The Berlin Iron Bridge Company, of East Berlin, Conn., has taken the contract to build a Producer Building for the Solvay Process Company, of Syracuse, N. Y. The building will be 30 feet wide, 100 feet long, and three stories high, built entirely of iron, even the floors being made of plate iron, in order that there may be no woodwork about the building to take fire.

Charles O. Smith & Co., electrical machinists, 177 Grand street, New York, make a specialty of electrical repair work of all kinds, and also of armature and magnet winding of all systems. Their plant is fitted with all the appliances necessary to do first-class work promptly and efficiently, and they take as much pains to do petty jobs first-class as to undertake the repair in the most perfect manner possible of difficult and intricate work.

The Electric Appliance Company has closed arrangements to represent the Security Insulator Company in the West, and will carry a large stock of itsspecialty. The Security insulator, it is claimed, combines the features of the insulator and the cleat. The wire is held firmly without the use of tie wires or fasteners—the greater the strain, the tighter the hold. Its contact with the wire is made as small as possible, so as to increase the insulation resistance.

Mr. E. L. Babcock, of the Falls Rivet and Machine Company, Cuyahoga Falls, O., has secured some excellent photographs of the transmission machinery installed by his company in the extensive power plant of the Columbus (Ohio) Consolidated Street Railway Company, where a Falls Rivet pulley, twelve feet in diameter, with a 38-inch face, is mounted on a single steel shaft 10 inches in diameter and 36½ feet in length, and drives 500 h. p. at 100 revolutions.

Queen & Co., of Philadelphia, state that they have recently received an order for more than 200 magnetic vane volt and ampère meters from a large manufacturing concern, which instruments are to be installed with the light and power plants put up by this company. The transaction is especially satisfactory to the makers, as a sort of competitive examination was instituted and the magnetic vane type was adopted, it is stated, after the most careful comparison with other types.

The Ansonia Brass and Copper Company, of 19 Cliff street, New York, is sending out a descriptive circular of the Tobin bronze metal, which it manufactures. It gives detailed information in regard to this metal, refers to some considerable extent to a report of tensile tests made for the company by N. O. Olson, engineer, 84 Thomas street, New York. It also contains a large number of testimonials from users of Tobin bronze, relative to its merits and the satisfaction it is giving.

The Toronto Construction and Electrical Supply Company, of Toronto, Can., is sending out a very complete catalogue and price list for 1892. It is well illustrated, covers nearly 300 pages, and gives a list of all the specialties and electrical machinery supplies and apparatus handled by the company. The frontispiece of the catalogue is made up of two photo engravings, one giving a general view of the company's offices and warehouse in Toronto, the other a view of the five exhibits made by the company at the National Electric Light Convention held in Montreal last September.

Mr. Willis H. Post, Southwestern manager A. L. Ide & Son, Fort Worth, Tex., has lately made the following sales of Ide engines to electrical companies: Decatur Electric Light and Ice Company, Decatur, Tex., one Ideal engine, 35 h. p.; Denton Water and Electric Light Company, Denton, Tex., one Ideal engine, 60 h. p.; Calvert Water, Ice and Electric Light Company, Calvert, Tex., one Ideal engine, 45 h. p.; Fort Worth & Arlington Heights Street Railway, Fort Weight, Tex., two Ideal engines, 250 h. p.; Camden Electric Light and Power Company, Camden, Ark., one compound Ideal engine, 150 h. p.

H. D. Nuttal Co., of Allegheny, Pa., are manufacturing a drawn steel trolley pole, which is made from one piece of solid steel tube, drawn and tapered by degrees and finished without joints, soldering or lap welding. From the large number of orders received it would seem that this pole is in great demand. It is made light and durable, and is reinforced in the end fitting the trolley base. The manufacturers state they have manufactured over 2,000 during the past three weeks. They have recently opened a new department for winding armatures, making armature cores and shafts complete, and also making tempered copper commutators for any system.

The Hoppes Manufacturing Company has just issued a letter warning its customers that the statements being made by the Stilwell & Bierce Manufacturing Company to the effect that the Hoppes purifier is an infringement on the Stilwell patent are not true. The court decides that the purifier was not an infringement, but that a certain arrangement of the pipes made by a customer was. The decision, it is claimed, does not affect the use of either the live steam feed-water purifier or the exhaust steam feed water heater of the Hoppes Company. The case has been carried to the United States Circuit Court of Appeals.

The Fitchburg Steam Engine Company, of Fitchburg, Mass., has removed into its new quarters. For several years there has been an increasing demand for the engines which the company manufactures until it was unable to keep up with its contracts, although running nights for some time. The new factory is fitted throughout with all the best modern tools and facilities for handling large work, such as traveling cranes, etc., and is more than twice the size of the old plant. The facilities for shipping are the best, as engines can be loaded directly from the erecting room on to the cars. The company is now in shape to fill all orders promptly for either large or small, vertical or horizontal, high speed, slow speed or compound condensing engines.

E. W. Bliss Company, Limited, of Brooklyn, N. Y., is sending out a catalogue which is attracting considerable attention. It has been the habit of this company for a number of years to issue a handsomely bound book of from 200 to 400 pages, containing carefully made wood-cuts of its various machines and tools, with tables of dimensions, capacity, prices, etc. These books have been attractively bound in cloth, and each edition has cost a large sum of money. Recently the idea of sectional catalogues, or catalogues to be compiled according to the individual wants of customers, has been introduced. For the purpose of enclosing with letters, duplicate pages of the bound catalogue, as heretofore employed, were printed. The new idea is to use these pages exclusively, having them punched, ready to fasten in a temporary binder with appropriate title pages, etc. To carry out this plan each page, of necessity, has been made complete, so far as illustration of device and table of prices are concerned. Single sheets are used in enclosing in letters, and then, as already mentioned, a number of them are combined from time to time to meet special requirements. Accordingly, a customer who is interested, for example, in drop presses is not sent a book which has a few pages devoted to drop presses and all the balance to tools for which he has no use. Instead, he receives the pages illustrating the drop presses which the company manufacture, put up in a neat cover. By the old plan it was necessary to wait until a previous edition of the catalogue was exhausted before getting up a new one, which would include new machines. Several months would necessarily elapse before the completion of the new catalogue, and by the time it was out still other new machines would be ready, which, unfortunately, were not included in the book then being mailed. It was found impossible to keep it up to date. Again, certain machines and types of tools would be discarded from time to time, but could not be withdrawn from the catalogue except by mutilation. By the plan now adopted the catalogue is progressive. When a new machine or tool is prepared, a sheet describing it is at once printed and it is then included in the books as made up for distribution. In turn, if a machine or type of tool is discarded, the printed sheets representing it are at once destroyed, so that it is no longer advertised. Changes in prices are similarly managed, each sheet being complete so far as figures are concerned.

Business Notices.

Battery Cut-Out, Cheap.—Sensitive, reliable, never requires attention. Gas lighting much improved by its use. Electric Supply Company, of 105 South Warren street, Syracuse, N. Y.

35-light, 2,000-c. p. American arc dynamo, in good condition, for sale at a bargain; also 750-light Westinghouse alternator, with station appliances. Address E. T. Pardee, 10 Butler Building, Syracuse, N. Y.

Homer Brooke, manufacturer of molds, tools, etc., for glass manufacturing and other uses. Molds a specialty, casting for glass, zinc, lead, carbon, etc. Every facility and experience for these specialties. Address 44 Barclay street, New York.

OUR ILLUSTRATED RECORD OF ELECTRICAL PATENTS.

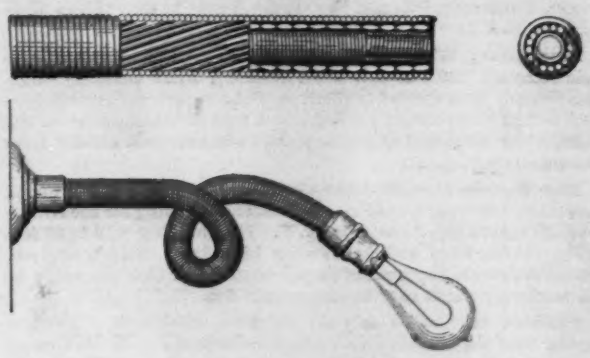
U. S. PATENTS ISSUED APRIL 12, 1892.

472,529. Insulator Support; Dennis Doren, of New York. Application filed July 20, 1891. The combination of a glass insulator, an iron pin for supporting the same, and a wooden thimble screwed thereon for making connection between said insulator and said iron pin. (See illustration.)

472,579. Electro-Magnetic Valve-Controller; Olof E. Lundstedt, of Brooklyn, N. Y., Assignor by mesne assignments, to the New York Electrical Device Company, of Virginia. Application filed Aug. 6, 1890. A cylindrical valve-casing having a peripheral port, a radial valve governing said port and oscillating upon an axis coinciding with that of the casing, an armature carried with that of the casing, an armature carried by the valve upon the opposite side of its pivotal axis, an electromagnet mounted externally upon the casing, having its poles extended through the same to attract the armature and move the valve in one direction, and a spring operating to retract the armature and carry the valve in the opposite direction.

472,598. Trolley-Wire Clamp; Montraville M. Wood, of Chicago, Ill. Application filed May 14, 1891. In a trolley-wire clamp, the combination of two independent clamping portions pivotally supported one upon the other and provided at one extremity with coacting clamping-jaws and at the other with means for securing the clamp to its support and adjusting the jaws with reference to each other.

472,610. Electric Switch; Lucius T. Stanley, of Brooklyn, N. Y., Assignor to the Cutter Electric and Manufacturing Company, of Philadelphia, Pa. Application filed September 24, 1891. A mechanical movement for electrical switches and other purposes, consisting in the combination of a pivotal lever or part to be shifted, stops for limiting the movement of the same, an operating part or handle capable of movement independently of the lever, and a flat resilient strip, one end of which is permanently secured to the pivotal lever eccentrically and the other end to a point on the operating part that is movable across the line joining the fulcrum of the lever and the point thereon to which the strip is connected. (See illustration.)



No. 472,611.—Flexible Supporting Arm for Electric Lamps.

472,611. Flexible Supporting Arm for Electric Lamps; Lucius T. Stanley, of Brooklyn, N. Y., Assignor to the Cutter Electric and Manufacturing Company, of Philadelphia, Pa. Application filed Oct. 17, 1891. A flexible supporting arm consisting of a hollow core formed of spirally wound strands of ductile wire in combination with an outer spiral of resilient wire. (See illustration.)

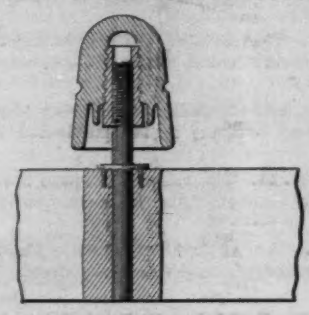
472,623. Electric Lighting System; John M. Lockwood, of San Francisco, Cal. Application filed June 22, 1891. The device herein described for indicating and locating disturbances in electric circuits, the same consisting in the combination of a solenoid connected in the main circuit, a bar adapted to move therein, a train of gearing adapted to be automatically wound by the movement of the bar, a rotating disc and brush adapted to be connected in circuit with an alarm or indicator at the source of generation, and a plate at the upper end of the bar, adapted to arrest the movement of the gearing when the signal has been given.

472,628. Dynamo-Electric Machine; Lazarus Simon Magnus Pyke and Harry Theodore Barnett, of London, England, Assignors to said Pyke and Edward Stephen Harris, of same place. Application filed Feb. 5, 1892. In a dynamo-electric generator, the combination of an annular stationary electromagnet having its coil inclosed by the magnetizable mass, as described, two concentric circles of laminated polar projections arranged in radial pairs in the same plane and serving as cores for the secondary coils, and sector-shaped laminated magnetic inductors revolving in front of and in proximity to the polar projections, so as to commute the lines of force, the inductors corresponding in breadth to the pitch of the polar projections.

472,634. Bracket for Electric Heaters; George D. Burton, of Boston, Mass., Assignor to the Electrical Forging Company, of Maine. Application filed June 26, 1891. In an electric heating apparatus, the combination of a current converter having two conducting rings, one of which is provided with a slot, conductive brackets connected with said rings, one of said brackets being provided with a perforated ear engaging one of said rings, and a bolt passing through said ear, and engaging said slot.

472,643. Electric Conductor; William R. Patterson, of Chicago, Ill. Application filed Aug. 31, 1891. An electrical conductor insulated with a composite covering of fibrous material and waterproof insulation, the water proof insulation forming the entire outer coating of the covering, and alternating with the fibrous insulation in longitudinal annular sections next the conductor.

472,688. Alarm for Hot Axles; Anton Backhaus, of Altenburg, Saxe-Altenburg, Germany. Application filed Sept. 4, 1891. The combination, with the axle or shaft bearing, of a thermometer having an expansible electrical conducting medium, and circuit wires normally out of contact with said medium and in circuit with a signalling or alarm apparatus, and a second chamber containing circuit wires, and a fusible electrical medium making contact with the ends of said wires in the chamber when fused, the expansible electrical medium being adapted to be brought into action to close the circuit of its wires at a lower temperature than the fusible electrical medium and the latter to be brought into action after the other medium has established its circuit.



No. 472,529.—Insulator Support.

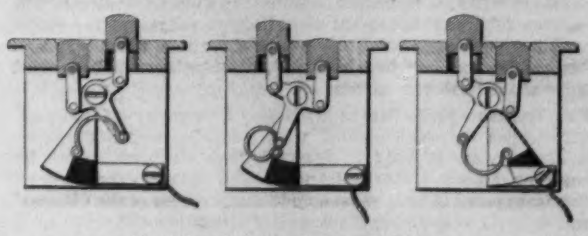
472,708. Electric Motor and Generator; Rudolph M. Hunter, of Philadelphia, Pa., Assignor to the Thomson-Houston Company, of Connecticut. Application filed Nov. 12, 1891. An electric motor or generator having a revolving armature arranged between two poles, combined with distorting coils upon the field magnets, electric circuits independent of the armature for causing the current to flow through said distorting coils, and switches independent of the armature circuit for controlling the flow of the current through said coils, whereby the magnetic poles of the electric motor or generator may be distorted to permit the reversal of the armature or change of speed without shifting the brushes (See illustration.)

472,747. Electric Arc Lamp; Royal E. Ball, of New York. Application filed Oct. 10, 1891. An electric arc lamp having a carbon reciprocating or swinging transverse the direction in which it is fed.

472,772. Circuit for Multiple Switchboard Systems of Telephone Exchanges; John A. Seely, of New York, and Charles E. Scribner, of Chicago, Ill., Assignors to the Western Electric Company, of Chicago, Ill. Application filed Nov. 15, 1886. In a multiple switchboard system of a telephone exchange a metallic circuit, one limb of which is connected normally at the subscriber's station through switch, generator and bell to ground, and at the central office with its switches on two or more multiple switchboards, and through an individual annunciator to ground, and the other limb of said circuit consisting of a wire, normally open at the subscriber's station and connected at the central office with the insulated tubes or frames of the spring jacks of the line, in combination with a test wire connected with test pieces near the different spring jacks, keys upon the spring jacks and switching apparatus.

472,784. Safety Attachment for Overhead Electric Wires; Charles D. Brown, of Minneapolis, Minn. Application filed Jan. 8, 1891. The combination with the trolley wire and the supports thereof, of an overlying guard and loop extending from the trolley wire above and surrounding said guard, said guard being electrically connected with the ground.

472,800. Incandescent Electric Lamp; George C. Baillard, of New York. Application filed Sept 22, 1891. In an incandescent electric lamp, the combination of a base, a bulb permanently secured therein, a filament and tubular terminals of the filament on the base, fixed permanent electrical connections between the filament and terminals, and a transversely movable clamping plate, mounted on the base and constructed and having vertical clamping edges, past which the ends of the circuit wires extend when inserted into the tubular terminals, whereby, when the wires are inserted into the exposed terminals, the clamping device may be moved transversely, and its vertical edges caused to clamp or pinch the wires against the sides or edges of the tubular terminals.



No. 472,610.—Electric Switch.

472,801. Incandescent Electric Lamp; George C. Baillard, of New York. Application filed Sept. 22, 1891. An incandescent lamp, having in its base tubular filament terminals, the slotted clamping plate or cap movable transversely across said terminals to cover or expose them for the insertion of the ends of the circuit wires, whereby the ends of the wires may be clamped on the terminals by lateral strain, and a key in the side of the base.

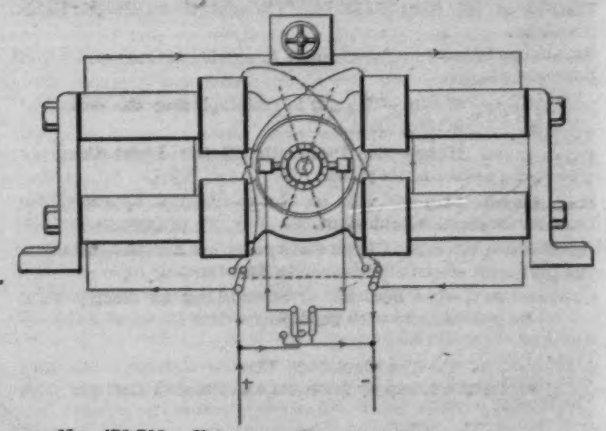
472,806. Adjustable Microphone; Hermann Otto Henneberg, Berlin, Germany, Assignor to Siemens and Halske, of same place. Application filed Oct. 10, 1891. In a microphone, the combination, with a frame, of a sounding funnel and vibrating plate or membrane secured together and rotatably mounted in said frame, a carbon plate secured to said membrane, a plurality of carbon bodies supported on a flexible disc, and pressing against said carbon plate, and means for regulating the pressure between said carbon bodies and said carbon plate.

472,810. Electric Railway Wire Suspension; Alexander Philipsborn and Walter Reichel, of Berlin, Germany, Assignors to Siemens & Halske, of same place. Application filed Nov. 27, 1891. In overhead conductors for electric railroads, the combination, with the working wire, of a second wire attached thereto and nearly parallel therewith, a rigid spreader between said wires, and a cross wire connected to said spreader between said working and second wires.

472,909. Electric Elevator; Charles R. Pratt, of New York. Application filed April 8, 1891. The combination of an electric driving motor, a second electric motor, a switch moved by the second motor, and controlling the circuit of the first motor, and a brake also controlled by the second motor.

472,933. Joint for Electric Conductors; Thomas F. O'Connor, of New York, Assignor to the Standard Underground Cable Company, of Pittsburgh, Pa. Application filed Jan. 2, 1892. A joint for electric cables, comprising a block of insulating material having peripheral grooves, in which grooves the bare ends of the conductors are united and secured.

472,935. Arc Light Hanger; Charles A. Pfluger, of Chicago, Ill., Assignor by direct and mesne assignments to the Standard Electric Company, of Illinois. Application filed May 11, 1891. In an arc light hanger, the combination of a support with hooks suspended therefrom and adapted to engage each one terminal of the lamp and levers connected with such hooks and adapted to engage some portion of the lamp, whereby the hooks are held out of the path of the lamp terminals when the lamp is descending.



No. 472,708.—Electric Motor and Generator.

472,943. Dynamo-Electric Machine; George Edward Dorman, of Chicago, Ill., Assignor to the Standard Electric Company, of Illinois. Application filed Dec. 17, 1890. In a dynamo-electric machine, a series of inwardly projecting pole pieces, in combination with a series of coils about such pole pieces, each of said coils being curved to conform with the surface of a cylinder.

472,947. Cable Rack; William M. Goodridge, of Highland Park, Assignor to the Western Electric Company, of Chicago, Ill. Application filed Nov. 30, 1888. A cable rack consisting of upright pipes and pins inserted in holes provided therein; said rack being placed at the rear of the uprights of the frame is relieved from the weight of the cables.

472,953. Trolley Wire Support; Frank C. Prickett, of Kansas City, Kan., Assignor of one-half to Frederick W. Bruchmann, of same place. Application filed Dec. 14, 1891. An improved support for trolley wires, comprising a vertical bar having at one side a cavity, and a groove communicating with said cavity at its lower margin and opening at opposite sides of the bar, and a retaining plate connected to the side of the bar and overlying the cavity and groove.

472,956. Canopy Telephone Exchange Switchboard; Charles E. Scribner, of Chicago, Ill., Assignor to the Western Company, of same place. Application filed Nov. 22, 1889. The combination, with a switchboard containing the switches of a portion of the telephone lines of an exchange, of a canopy board containing the switches of other lines of the exchange.

472,968. Electrical Surgical Instrument; Stephen R. Bradley, of Nyack, N. Y. Application filed Feb. 4, 1892. The above described instrument, comprising a finger sheath, wires extending from the interior of the sheath to or near the exterior of a bulb at the other end of the instrument, an elastic exterior bulb or covering for the said bulb, the inner surface whereof is a conductor of electricity, and a wire extending to the said inner surface of the exterior bulb.

Copies of the specifications and drawings complete of any patent mentioned in this record—or of any other patent issued since 1886—can be had for 25 cents. Give date and number of patent desired and address The W. J. Johnston Co., Ltd., Times Building, N. Y.